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US-A- 4 368 118

(73) Proprietor: **Mitsubishi Oil Company, Limited**
no. 2-4, Toranomon 1-chome
Minato-ku Tokyo (JP)

(72) Inventor: **Yano, Hisashi**
1019-233, Aza Araisawa
Kuden-cho
Sakae-ku
Yokohama-shi Kanagawa (JP)
Inventor: **Ihara, Hiroyuki**
1-3-23, Tarumachi
Kohoku-ku
Yokohama-shi Kanagawa (JP)
Inventor: **Yabumoto, Junsuke**
48-8, Nakaechi
Atsugi-shi
Kanagawa (JP)
Inventor: **Kuwavara, Ryuzi**
35-1, Matsumi-cho 1-chome
Kanagawa-ku
Yokohama-shi Kanagawa (JP)
Inventor: **Nishiya, Masanori**
19-28-603, Jukkenzaka 3-chome
Chigasaki-shi Kanagawa (JP)

(74) Representative: **Abbie, Andrew Kenneth et al**
R.G.C. Jenkins & Co.
26 Caxton Street
London SW1H 0RJ (GB)

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EP 0 376 443 B1

Description

The present invention relates to an oil filter suitable for incorporation in a lubricating system and, more particularly, to an oil filter of a type in which not only solid contaminants but also gaseous contaminants can be removed from the oil.

In machinery for construction, transportation and the like using lubricant, such as engines and various hydraulic devices, solid contaminants and gaseous contaminants have hitherto been removed from lubricant by separate devices and/or in different portions of the machinery. An integrated device has thus been desired which can remove both of the solid and gaseous contaminants effectively and which can be installed in a limited space of the machinery.

EP-A-0 164 882 discloses an oil filter comprising a housing, a cylindrical filter element for removing solid contaminants removably mounted in said housing, an end plate attached to each respective end of said cylindrical filter element, and a separator for removing gaseous contaminants disposed within the space defined by the inner periphery of the cylindrical filter element.

In EP-A-0 342 308, which is part of the state of the art under EPC Article 54(3) (This application has been filed on 23.01.89 and published on 23.11.89), the inventors of the present invention disclose an oil filter which comprises a first separator for filtering lubricant which is pumped into a housing to thereby remove solid contaminants, and a second separator for removing gaseous contaminants from the filtered oil by utilizing a centrifugal force. Specifically, the second separator has a chamber adapted to generate a vortical flow of the lubricant introduced therein, whereby the gas-lean lubricant and therefore having a larger specific gravity gathers in a peripheral area of the chamber while gas-rich lubricant having a smaller specific gravity gathers in a central area. A wall defining the chamber is provided with a plurality of pores through which the gas-removed lubricant flows out of the chamber. On the other hand, the gas-rich lubricant is discharged by a perforated pipe which extends into the chamber along its axis.

In the above proposed device, the second separator projects in the axial direction beyond the first separator unit. Therefore, the axial length of the device must be sufficiently larger than that of each separator, resulting in a difficulty in designing the device to be installed in a small space without spoiling the removal efficiency of contaminants. Further, to incorporate the device into a lubricating system necessarily involves attaching it to a mount in which various passages should be provided to supply the lubricant into the device, lead the filtered and gas-removed lubricant to various parts to be lubricated, and to discharge the gas-rich lubricant into a tank for recirculation. The above device is not so constructed that it may easily be attached to the mount, and a relatively complicated work will be needed for the attachment.

Accordingly, an object of the invention is to provide an oil filter which can efficiently remove both solid and gaseous contaminants from the oil and which can be miniaturized in dimension without spoiling the removal efficiency.

According to the present invention there is provided an oil filter suitable for incorporation in a lubricating system, comprising a housing, a cylindrical filter element for removing solid contaminants removably mounted in said housing, an end plate attached to each respective end of said cylindrical filter element, and a separator for removing gaseous contaminants disposed within the space defined by the inner periphery of the cylindrical filter element, characterised in that said separator is disposed entirely within the space defined by the inner periphery of the filter element between said end plates.

Preferably, the separator is arranged to remove gaseous contaminants from oil which has passed through said filter element.

Also preferably, the separator includes a chamber adapted to generate a vortical flow of oil introduced therein for separating the oil into gas-rich oil and gas-lean oil.

The oil filter may comprise a first outlet passage means for said gas-rich oil and a second outlet passage means for said gas-lean oil, said first and second outlet passage means extending into said housing through an open end thereof.

The separator preferably includes a cylindrical casing having an open end and a closed end formed by an end wall, a cyclone secured in said casing for defining said chamber in cooperation with said end wall, and an inlet formed in the casing for introducing the oil into said chamber along a tangential direction of said casing.

The first outlet means may comprise a removal pipe extending into said chamber along the axis of said cyclone and having formed in the wall thereof a plurality of orifices for permitting the gas-rich oil to flow thereinto.

The second outlet means may comprise a plurality of pores formed in a wall defining said cyclone.

The invention also includes an oil filter comprising:

a housing open at one end thereof;

a first separator unit disposed in said housing for removing solid contaminants from the oil introduced into said housing, said first separator unit including a cylindrical primary filter element and a cylindrical secondary filter element aligned with each other, said secondary filter element being finer than said primary filter element;

a second separator unit for removing gaseous contaminants from the oil that has passed through said primary filter element, said second separator unit being accommodated entirely within the space defined by inner peripheries of said primary and secondary filter elements, said second separator unit including a chamber adapted to generate a vortical flow of the oil introduced therein to thereby separate gas-rich oil which gathers in an axially central portion of said chamber;

a first outlet passage means for discharging outside said housing said gas-rich oil and the oil that has passed through said secondary filter element; and

a second outlet passage means for leading gas-lean oil outside said housing;

said first and second outlet passage means extending into said housing from the open end thereof.

In order that the invention may be well understood, some embodiments thereof, which are given by way of example only, will now be described with reference to the accompanying drawings, in which:

FIG. 1 is a longitudinally sectioned elevational view illustrating an oil filter according to an embodiment of the invention;

FIG. 2 is a cross-sectional view of a second separator unit in the oil filter of FIG. 1;

FIG. 3 is a fragmentary sectional view showing another form of an inlet in the second separator unit;

FIG. 4 is a view similar to FIG. 1 illustrating an oil filter according to another embodiment of the invention;

FIGS. 5(A) and (B) are fragmentary views of cyclones in second separator units of FIG. 1 and FIG. 4, respectively;

FIG. 6 is a view similar to FIG. 1 illustrating an oil filter according to still another embodiment of the invention;

FIG. 7 is a partly cut-away perspective view of a cyclone in FIG. 6;

FIG. 8 is a view similar to FIG. 7 showing a modified form of the cyclone;

FIG. 9 is a longitudinally sectioned elevational view of another preferred form of a cyclone;

FIG. 10 is also a longitudinally sectioned elevational view for use in explaining dimensional relation between a cyclone and a removal pipe;

FIG. 11 is a view similar to FIG. 1 illustrating an oil filter according to still another embodiment of the invention;

FIG. 12 is also a view similar to FIG. 1 of an oil filter according to a further embodiment of the invention;

FIG. 13 is a view showing a slightly modified form;

FIG. 14 is a longitudinally sectioned elevational view illustrating an oil filter according to still further embodiment of the invention;

FIG. 15 is also a longitudinally sectioned view of an oil filter according to still another embodiment of the invention; and

FIG. 16 is a view similar to FIG. 15 showing a modified form thereof.

Referring first to FIG. 1 of the drawings, an oil filter according to a first embodiment of the invention has a housing 10 of substantially cylindrical shape having a lower open end and an upper closed end. A base plate or disk 12 is secured to an inner peripheral surface of the housing 10 at a position near its lower end and is fixedly supported by means of a ring member 14 of which outer edge is seamed with the lower edge of the housing 10. The base plate 12 is formed with a central opening 16 defined by an upwardly projecting circular wall 18 which has a threaded inner surface 18a. An aperture 20 is provided in the base plate 12 radially outward of the opening 16, and is surrounded by a gasket 22 that seals a space between the base plate 12 and an upper surface of a mount block 24 to which the housing 10 is attached.

Arranged within the housing 10 are a separator unit A for separating solid contaminants from an oil circulating in a lubricating system of a machine, and a separator unit B for separating gaseous contaminants in the oil. The separator unit A is of usual type and comprises a filter element 26, an upper end plate 28 and a lower end plate 30 both fixed to the element 26. The filter element 26 has a hollow cylindrical shape and is typically formed of a pleated sheet. The upper end plate 28 extends radially inward to support a relief valve 32 which is positioned substantially at a center of the housing 10. This relief valve 32 is adapted to open and provide a bypass passage for the oil when a pressure of oil is increased outside the filter element 26 due to a clogging thereof, so that the oil can flow through the valve 32 into the space defined within the element 26. On the other hand, the lower end plate 30 extends to the wall 18 where a check valve 34 is secured for preventing a reverse flow of the oil from the housing into an inlet passage 36 that is formed in the mount block 24 and communicates with the aperture 20 in the base plate 12. The unit A is

held in position by a spring 38 which is compressed between the upper end of the housing 10 and the upper end plate 28.

The separator unit B is disposed at the center of the housing 10 and has a length along an axis of the housing smaller than the length of the unit A so that it is entirely surrounded by the filter element 26 and is accommodated between the upper and lower end plates 28 and 30. The unit B includes a cylindrical casing 40 of which lower edge is secured to the extension of the end plate 30. A funnel-shaped member or cyclone 42 is housed within the casing 40 and is attached at its upper vertical portion to the peripheral surface of the casing 40, defining together with an end wall 41 of the casing 40 a chamber 44 which is adapted to create a vortical flow of the oil as described hereinafter. The end wall 41 has at a center thereof a concave portion 46 projecting into the chamber 44. Formed through the peripheral wall of the casing 40 at a position above the cyclone 42 is an inlet 48 for introducing the oil into the chamber 44. If desired, plural inlets may be provided at angular intervals. As shown in FIG. 2, the inlet 48 is formed by punch press to provide a guide wall or deflector 50 extending inwardly relative to a tangent of the casing 40 at the inlet 48 so that the oil introduced therethrough flows in a vortical pattern.

Instead of providing the deflector, the inlet itself may be so formed as to extend along the tangential direction if the peripheral wall of the casing 40 has a sufficient thickness. Alternatively, a guide plate 52 is formed separately from the casing 40 and is welded thereto at a position opposite to and overlapping the deflector 50, as shown in FIG. 3. In FIG. 2, arrows indicate a direction of flow of the oil.

Referring again to FIG. 1, the concave portion 46 preferably extends to a level equal to or below the inlet 48 so that the periphery of portion 46 may fully contribute to the generation of vortical flow. A plurality of pores 54 are formed through the wall of the cyclone 42 to connect the chamber 44 with a space 56 which is defined between the cyclone 42 and the casing 40 and communicates with the central opening 16. A removal pipe 58 having an upper closed end extends in the opening 16 and projects into the cyclone 42. The lower vertical portion of cyclone 42 is fixed to the pipe 58 to orient the latter along the axial center of the chamber 44. The upper portion of pipe 58 in the chamber 44 is formed with small orifices 60 through which a gas-rich oil flows into the pipe 58 as described later.

The mount block 24 has a central hole 62 which is aligned with the opening 16 and communicates with a first outlet passage 64 formed in the block 24. The removal pipe 58 extends through the central hole 62 and in the first outlet passage 64, and its lower end opens into a second outlet passage 66 that is also formed in the block 24 below the first passage 64. An O-ring 69 is provided around the pipe 58 to separate the first and second passages from each other. The first passage 64 is connected to, for example, an engine (not shown) to be lubricated while the second passage 66 is connected to, for example, an oil pan (not shown) for storing the oil. A pressure-regulating valve 68 is disposed in the removal pipe and adapted to open for discharging the gas-rich oil to the oil pan through the second passage 66 when a pressure in the pipe 58 exceeds a predetermined value. Fitted in the central hole 62 is a sleeve 70 which extends into the opening 16 to threadedly engage with the wall 18 of the base plate 12, thereby attaching the housing 10 to the block 24.

When the oil is supplied by a pump P via the inlet passage 36, it flows into the oil filter through the aperture 20 and the check valve 34. The oil then passes through the filter element 26 from outside to inside during which solid contaminants are removed from the oil. The thus filtered oil flows in the space between the element 26 and casing 40 and is introduced into the chamber 44 through the inlet 48 which, together with the deflector 50, contributes to the creation of vortical flow. The concave portion 46 prevents the oil from flowing radially inwardly and intensifies the vortical flow. The oil flows downward in the chamber 44 with the vortical pattern, generating a centrifugal force which acts on the oil. Due to a difference in density, the oil containing gaseous contaminants, i.e. gas-rich oil, is separated and gathers near the axial center of the flow where it is introduced through the orifices 60 into the removal pipe 58 for discharge into the oil pan via the second outlet passage 66. On the other hand, the remaining oil, which is gas-lean, flows around the wall of cyclone 42 and passes through the pores 54 into the space 56 for circulation in the lubricating system via the central opening 16, hole 62 and the first outlet passage 64.

In this way, solid and gaseous contaminants can efficiently be separated and removed from the oil. Attachment of the housing 10 to the mount block 24 is facilitated since the removal pipe 58 extends in the attachment sleeve 70 which also provides the passage for the filtered oil. Further, the unit B for separating gaseous contaminants is completely accommodated within the unit A for separating solid contaminants both in the radial and axial directions that is unit B is disposed entirely within the space defined by the inner periphery of the filter element 26 between the end plates 28,30 thereof. This enables the whole device to be miniaturized and facilitates assembly and attachment thereof. The downwardly extending passages allow the relief valve 32 to be arranged at the axial center in the upper part of housing 10, so that the valve 32 may effectively function in response to the increase of oil pressure.

In FIG. 1, an angle θ of the cyclone 42 should preferably be in the range from 20 to 120 degrees, more preferably from 40 to 80 degrees. This serves to prevent an occurrence of turbulence of the oil and to increase an angular acceleration of the vortical flow.

FIG. 4 illustrates an oil filter according to another embodiment of the invention, which is different from the above embodiment in a shape of cyclone 72. Thus, the cyclone 72 has a parabolic shape in longitudinal cross section containing a center axis thereof, the parabola converging to the lower end which defines an aperture for the removal pipe 58. Because of the parabolic shape, the cyclone 72 has a surface area larger than that of the funnel-shaped cyclone 42 in FIG. 1. This enables the number of pores 74 to be increased to permit the gas-lean oil to flow out of the cyclone 72 more quickly and smoothly. Further, as can be seen from FIGS. 5(A) and (B), a distance "d" between the removal pipe 58 and the cyclone 72 at the lower part of the latter is substantially larger than a distance "D" at the corresponding point in the funnel-shaped cyclone 42. Such a larger distance is advantageous in preventing the gas-rich oil from mixing with the oil flowing in the outer portion of the chamber, resulting in an improved separation or filtering of the oil.

Another preferred form of cyclone is shown in FIGS. 6 and 7 in which a helical guide 78 is fixed between an inner surface of a cyclone 76 and the outer surface of removal pipe 58. The guide 78 has an upper end positioned just below an inlet 80 and extends in the direction of oil flow to the lower end of the cyclone 76. The oil introduced into the chamber through inlet 80 flows downwardly along the helical guide 78, so that the vortical flow of the oil is intensified to strengthen the centrifugal force. A helical pitch of the guide 78 may be determined in view of an initial velocity of the oil at inlet 80 etc. As in the above embodiments, the cyclone 76 is formed with pores 82 through which the separated gas-lean oil passes into the space 56.

A variation in FIG. 8 includes a large-diametered column 84 attached to the upper end of pipe 58, and a helical guide 86 having a reduced width around the column and terminating at the axially intermediate portion of the cyclone 76. The column 84 restrains the oil through the inlet 80 from flowing radially inward. That is, even if a portion of the oil flows toward the center of chamber, the column 84 forcedly changes the direction of flow into the vortical pattern along the guide 86. Because the vortical flow is intensified at the initial stage, it can be fully maintained to the lower end of cyclone 76. If desired, the column may be provided with orifices communicating with the pipe 58.

When the funnel-shaped cyclone is employed, it is preferable that the pores are provided in the wider upper and intermediate portions of the cyclone and that the narrower lower portion thereof is not perforated, as illustrated in FIG. 9. This is preferable because the gas-rich oil flowing around the pipe 58 would be apt to flow into the space 56 if the pores were formed in the lower portion where the wall of cyclone approaches the pipe 58. In the illustrated example, an entire length of the conical portion as measured along the slope is indicated by "L" and only the portion having two-thirds (2/3) of L from the upper end of the wall is formed with pores 90 of which size increases toward the narrower lower end of the cyclone 88, i.e. in a downstream direction of oil flow. The uppermost, smallest pores have a diameter of about 0.5 mm while a diameter of the lowermost, largest ones is about 5 mm, for example. Such dimensional variations permit the oil to flow around the wall of cyclone with a pressure loss of less than 1 kg/cm^2. Also, the oil flow increases its velocity toward the lower portion of cyclone, and the increasing size of pores 90 allows the filtered oil to flow out therethrough efficiently.

The present inventors have found through extensive experiments that a ratio of the outer diameter X of the removal pipe 58 to a maximum inner diameter Y of the funnel-shaped cyclone 42 (see FIG. 10) should be set within a particular range, in order to remove gaseous contaminants effectively without substantially lowering an oil pressure at the lubricating system. The inventors manufactured several samples of cyclones in which the ratio X/Y was varied from 0.5 to 0.1, incorporated each sample into the oil filter of FIG. 1 and mounted the latter to an engine for measurement of removal efficiency of gaseous contaminants in the oil. The removal efficiency was measured by operating the engine at constant speed for a predetermined period of time, extracting a fixed volume of oil from the lubricating system into a test tube to measure a weight "w", and comparing that weight with a weight "W" of another test tube which contains the same volume of fresh oil having no gaseous contaminants. The following Table shows the results of the experiments in which the engine speed was varied between 3,000 and 6,000 rpm, the removal efficiency w/W being indicated in percentage.

TABLE 1

X/Y*	0.5	0.35	0.20	0.15	0.10
Engine Speed (rpm)					
3000	98.0	98.8	99.2	99.1	97.4
4000	96.4	97.2	97.6	97.6	94.7
5000	94.1	95.7	96.3	96.3	89.5
6000	93.5	94.4	94.9	95.0	87.2
				(%)	

* X: Outer diameter of removal pipe

Y: Maximum inner diameter of cyclone

As can be seen from the Table 1, the removal efficiency was remarkably lowered in each engine speed when the diameter ratio X/Y was reduced below 0.15 and set at 0.10. On the other hand, the ratio X/Y exceeding 0.35 and setting at 0.50 did not critically affect the removal efficiency but was found to substantially lower the oil pressure at passage 64 due to an increase of oil that flowed into the pipe 58 through orifices 60. This causes a shortage of oil to be supplied to the engine. Therefore, the diameter ratio X/Y should preferably be set between 0.15 and 0.35.

Also, a preferable size of orifice 60 is in the range from 0.5 to 10 mm in diameter, more preferably from 1.0 to 5.0 mm, and the orifices 60 are uniformly distributed around the pipe 58. Such size and arrangement of orifices allow the gaseous contaminants collected in the central portion of cyclone 42 to be quickly removed into the pipe 58 while minimizing the inflow of oil thereinto to maintain the pressure and flow rate of oil at sufficient level.

As is well known in the art, it is necessary to replace the filter element for separating solid contaminants with a new element when it is clogged after a long use, and the replacement requires detaching the oil filter from, and then attaching it to, the mount block. On the other hand, the separator unit B for separating gaseous contaminants is durable and can be used substantially permanently.

In an embodiment illustrated in FIG. 11, a base plate 100 has an upwardly projecting circular wall 102 defining a large-diametered central opening 104. An inner surface of the wall 102 is threaded as at 106, and the inner end of the lower end plate 30 of separator unit A abuts against an outer surface of wall 102. Threadedly engaged with the surface 106 is an outer circumferential surface of a base ring 108 on which the lower end of the casing 40 of separator unit B is fixedly mounted. The base ring 108 has also an inner threaded surface to engage with threads formed on an outer periphery of a sleeve 110 that is integral with a mount block 112 and extends from upper central portion thereof. The separator unit B is thus secured to the mount block 112. The base ring 108 is provided with a radial hole 114 in which a threaded pin 116 is fitted for preventing a rotation of the base ring 108 relative to the sleeve 110.

A relief valve 118 is attached to the center of upper end plate 28 for the purpose described above. The sleeve 110 defines a hole 120 which extends into the block 112 to communicate with a first outlet passage 122 leading to the engine. The removal pipe 58 extends in the hole 120 and opens to a second outlet passage 124 aligned with the hole 120 for discharging the gas-rich oil. Reference numeral 126 denotes a pressure-regulating valve in the pipe 58.

When it is desired to replace the filter element 26, the housing 10 is rotated relative to the mount block 112 whereby the wall 102 is released from the engagement with the base ring 108 which is retained by the pin 116 to the mount block 112 together with the separator unit B. In this way, the separator unit A as well as the housing 10 can easily be removed from the block 112 for replacement. Thereafter, the housing 10 is again attached by rotating it in the reverse direction.

A modified form is illustrated in FIG. 12 in which a base plate 130 has a generally L-shaped cross section of which inner end 132 extends downwardly and has a threaded outer surface to engage with threads 134 formed on the wall defining an inlet passage 136 in a mount block 138. A lower end plate 140

of the separator unit A slightly extends inwardly beyond the filter element 26 and is supported by a seat 142 disposed between the plate 140 and the base plate 130. The seat 142 has an aperture 144 for the oil from the passage 136 and a check valve 146 to prevent backflow of the oil. The passage 136 is further defined by a base ring 148 that is threadedly fitted on a central sleeve 150 of the block 138. The base ring 148 extends beyond the upper end of the sleeve 150 and is bent outwardly to form a flange 152 of which end surface is fixed to the lower end of casing 40 of the separator unit B. A gasket 154 is tightly fitted in the circular gap between the end plate 142 and the casing 40 to thereby completely define the passage 136. If desired, the base ring 148 is stationarily secured to the sleeve 150 by suitable means such as adhesive agent or a pin.

As in the embodiment of FIG. 11, the separator unit A can be removed from the mount block 138 by rotating the housing 10 and the base plate 130 fixed thereto relative to the block 138. The separator unit B, secured to the base ring 148, remains on the block 138.

An oil filter shown in FIG. 13 is different from the above one in that a sleeve 160 of the mount block 138 is formed with a spline 162 on which is fitted a base ring 164 having corresponding key ways 166. The spline 162 and key ways 166 prevent the base ring 164 from rotating relative to the block 138. A lower end plate 168 of the separator unit A extends inwardly to rest on the upper end of base ring 164 to which the casing 40 is attached at a shoulder 170. The unit A is thus held in position by the action of spring 38. Tightly fitted in a circular gap between the end plate 168 and base ring 164 is a gasket 172 which is formed integrally with a check valve 174 in the passage 136.

There has been known and available in the market an oil filter of a so-called center bolt type in which a center bolt extends axially through the housing for attaching it to the mount block. In applying the present invention to such an oil filter, attention should be paid to arrangements of the removal pipe and the center bolt. FIG. 14 illustrates one embodiment of the invention as applied to the center bolt type oil filter, which includes an axially elongated housing 210 for accommodating separator units A and B. An open end of the housing 210 is closed by a mount block 224 and sealed by a gasket 222 disposed on the lower peripheral edge 225 of block 224. The housing 210 is attached to the block 224 by means of a center bolt 212 which extends along a center axis of the housing and is threadedly engaged at its upper end with a hole 216 in the block 224. The lower end of center bolt 212 penetrates the bottom wall of the housing 210 with a gasket 214 to provide an enlarged head 213 for fastening or loosening the bolt 212.

As in the above embodiments, the unit A for separating solid contaminants comprises a filter element 226 and upper and lower end plates 228, 230. A gasket 215 is tightly fitted between the center bolt 212 and the lower end plate 230. Provided around the bolt 212 is a spring 238 which is compressed between the gaskets 214 and 215 for urging the unit A upwardly, whereby the upper end plate 228 abuts through a sealing member 217 against an end surface of a circular flange 232 to separate an inlet passage 236 from a first outlet passage 264, both formed in the block 224. The unit B, arranged within the unit A, includes a casing 240 attached at its upper edge to the inner periphery of end plate 228 and a funnel-shaped cyclone 242 secured to the casing 240. The center bolt 212 extends through the unit B along its axis, and suitable sealing such as an O-ring 243 is provided to prevent any leakage of the oil from the unit B around the bolt 212. A plurality of orifices 260 are formed in the bolt 212 to connect a chamber 244 in the cyclone 242 with a removal passage 258 extending centrally in the upper portion of bolt 212.

The oil supplied into the housing 210 via the inlet passage 236 passes through the filter element 226 while separating solid contaminants, and is then introduced into the chamber 244 from inlets 248. A pressure applied to the oil by a pump (not shown) causes the vortical flow toward the upper end of chamber 244, resulting in a separation of gas-rich oil which gathers around the center bolt 212 and is removed into the passage 258 via orifices 260. The gas-rich oil is finally discharged in an oil pan (not shown) through a second outlet passage 266 communicating with the passage 258. On the other hand, the gas-lean oil flows out of the cyclone 242 through pores 254 into an upwardly opened space 256 in the casing 240, and is led to the first outlet passage 264 connected to the engine. It will be understood that the housing 210 can be detached from the mount block 224 by disengaging the center bolt 212 from the hole 216.

Also, there has recently been developed a "dual type" oil filter having a primary or "full-flow" element and a secondary or "by-pass" element arranged side by side. The primary element is relatively rough and the secondary element is relatively fine. The oil filter of this type is so constituted that the oil passing through the primary element is supplied to the engine while the oil flowing through the secondary element is led to the oil pan, thereby improving removal efficiency of solid contaminants. Oil filters shown in FIGS. 15 and 16 are examples of the present invention as applied to the dual type device.

In FIG. 15, a base plate 312 is secured to an upper end of housing 310 by a seam 314 and has a central opening defined by a downwardly projecting circular wall 318 of which inner surface is threaded. An aperture 320 is formed through the base plate 312 to surround the wall 318. A mount block 324 includes a

downwardly extending sleeve 325 which is fitted in the central opening for threaded engagement with the wall 318. Fitted inside of the sleeve 325 is a tube 370 defining a first outlet passage 364 that is connected with the engine. The tube 370 further defines in cooperation with the sleeve 325 a slot 365 connected with a second outlet passage 366 leading to an oil pan. An inlet passage 336 is provided in the block 324 to open upon the aperture 320. The lower surface of block 324 is in tight contact with the periphery of base plate 312.

A separator unit A, for removing solid contaminants from the oil flowing into the housing 310 via aperture 320, comprises a primary or full-flow element 326 disposed in the lower portion of housing 310 and a secondary element 327 placed on the primary element 326. The primary element 326 is relatively rough and secured to upper and lower end plates 328, 330 while the secondary element is relatively fine and held between upper and lower end plates 329, 331. The end plate 331 lies on the end plate 328 and has an inward extension terminating at a flange 333 on which is fitted a pipe 334 extending to the tube 370 for providing a lower extension of the passage 364. The pipe 334 extends along a center axis of the secondary element 327 with defining an annular space 335 therebetween which is connected with the slot 365 through an opening 337 formed in a flange 339 of the end plate 329, the flange 339 being fitted on the tube 370 in a liquid tight manner. The unit A is held in position by a spring 338 disposed between the bottom wall of housing 310 and the end plate 330 on which a relief valve 332 is provided for the purpose set forth above. Arranged within the inner space of the primary element 326 is a separator unit B comprising a casing 340 fixed to the end plate 328 and a funnel-shaped cyclone 342 secured to the casing 340. A removal pipe 358 of the unit B has a crank outside the cyclone 342 to open in the annular space 335.

A part of the oil introduced into the housing 310 passes through the secondary element 327 and is discharged via the annular space 335, opening 337 and the slot 365 into the outlet passage 366. The remaining oil flows downward in the housing 310 to pass through the primary element 326, where it is introduced into the cyclone 342 from inlets 348, as indicated by arrows. During the vortical flow in the cyclone 342, gas-rich oil is removed through orifices 360 into the pipe 358 which leads it to the annular space 335 for discharge. On the other hand, gas-lean oil flows out of the cyclone 342 through pores 354 to be supplied to the engine via the outlet passage 364. Thus, the structure ensures the respective oil-flows without any mixture.

A modification of FIG. 16 is different from the above embodiment in that a separator unit B is arranged within the inner space of the secondary element 327 with the provision of a gap between the element 327 and a casing 372. The lower end of casing 372 as well as the lower end of a cyclone 374 is attached to the end plate 331 at a position surrounding the opening. A partition 376 is provided in the lower portion of cyclone 374 and has inlets 378 from which the oil that has passed through the primary element 326 is introduced to generate the vortical flow in the cyclone 374. The casing 372 includes an upper extension 380 of which end portion is fitted over the tube 370 so that the inner space of casing 372 communicates with the passage 364. A removal pipe 358 also has a crank to open in the annular space around the extension 380 for leading the gas-rich oil and the oil passing through the secondary element 327 to the outlet passage 366.

Claims

1. An oil filter suitable for incorporation in a lubricating system, comprising a housing (10; 210; 310), a cylindrical filter element (26; 226; 326; 327) for removing solid contaminants removably mounted in said housing, an end plate (28, 228, 328, 329; 30, 140, 168, 230, 330, 331) attached to each respective end of said cylindrical filter element, and a separator (B) for removing gaseous contaminants disposed within the space defined by the inner periphery of the cylindrical filter element, characterised in that said separator is disposed entirely within the space defined by the inner periphery of the filter element between said end plates.

2. An oil filter as claimed in claim 1, wherein said separator (B) is arranged to remove gaseous contaminants from oil which has passed through said filter element (26, 226, 326,).

3. An oil filter as claimed in claim 1 or 2, wherein said separator (B) includes a chamber (44, 244) adapted to generate a vortical flow of oil introduced therein for separating the oil into gas-rich oil and gas-lean oil.

4. An oil filter as claimed in claim 3 further comprising a first outlet passage means (58, 258) for said gas-rich oil and a second outlet passage means (62, 120) for said gas-lean oil, said first and second outlet passage means extending into said housing through an open end thereof.

5. An oil filter as claimed in claim 4, wherein said separator (B) further includes a cylindrical casing (40, 240) having an open end and a closed end formed by an end wall (41), a cyclone (42, 72, 76, 242) secured in said casing for defining said chamber (44, 244) in cooperation with said end wall, and an inlet (48, 80, 248) formed in the casing for introducing the oil into said chamber along a tangential direction of said casing.

6. An oil filter as claimed in claim 5, wherein said second outlet passage means comprises a plurality of pores (54, 74, 82, 90, 254) formed in a wall defining said cyclone.

7. An oil filter as claimed in claim 6, wherein said pores (90) are formed only in the wider end portion and the intermediate portion of said cyclone.

8. An oil filter as claimed in claim 7, wherein said pores (90) have varying dimensions, being gradually enlarged toward the narrower end portion of said cyclone.

9. An oil filter as claimed in any one of claims 5 to 8, wherein said first outlet passage means comprises a removal pipe (58) extending into said chamber along the axis of said cyclone and having formed in the wall thereof a plurality of orifices (60) for permitting the gas-rich oil to flow thereinto.

10. An oil filter as claimed in claim 9, wherein an outer diameter of said removal pipe (58) is in the range from 15% to 35% of a maximum inner diameter at the wider end portion of said cyclone.

11. An oil filter as claimed in claim 9 or 10, wherein said cyclone is funnel-shaped, in the smaller end portion of which said removal pipe is fitted.

12. An oil filter as claimed in any one of claims 5 to 10, wherein said cyclone (72) has a parabolic shape in longitudinal cross section containing the axis of said cyclone.

13. An oil filter as claimed in any one of claims 5 to 12, wherein said end wall (41) of said casing has formed at a central portion thereof a concave portion (46) projecting into said chamber to face said inlet (48).

14. An oil filter as claimed in any one of claims 5 to 13, wherein said separator (B) further comprises a helical guide plate (78, 86) attached to the inner surface of said cyclone for intensifying the vortical flow of the oil.

15. An oil filter as claimed in claim 14, wherein said separator (B) further comprises a column (84) attached to the inner peripheral surface of said guide plate (86) to face said inlet (80), said column having a diameter larger than a diameter of said removal pipe (58).

16. An oil filter as claimed in any one of claims 5 to 15, wherein said inlet (48) is formed by punch-pressing the wall of said casing to provide a deflector (50) extending substantially along a tangent of said casing at said inlet.

17. An oil filter as claimed in claim 9, wherein said removal pipe (58) has a pressure regulating means (68) whereby the gas-rich oil in said removal pipe is permitted to be discharged therefrom when a pressure in said removal pipe exceeds a predetermined value.

18. An oil filter as claimed in any one of claims 5 to 17, further comprising a base plate (12, 100, 130) fixed to said housing at the open end thereof, said base plate including an attachment means (18, 108, 132) for attaching said housing to a mount (24, 112, 138) in an oil lubricating system.

19. An oil filter as claimed in claim 18, wherein said base plate (12, 100) has formed therein an aperture (20) allowing the oil to flow into said housing.

20. An oil filter as claimed in claim 19, further comprising a check valve (34) arranged adjacent said aperture (20) for preventing a backflow of the oil.

21. An oil filter as claimed in any one of claims 18 to 20, wherein said base plate has a central opening (16).

22. An oil filter as claimed in claim 21, wherein said attachment means comprises a flange (18) formed on an inner periphery of said base plate (12) defining said central opening (16).

23. An oil filter as claimed in claim 22, wherein said flange (18) has a threaded inner surface (18a).

24. An oil filter as claimed in claim 22 or 23, wherein said end plate (30) of said filter element (26) closer to the open end of said housing extends inwardly to abut against the outer surface of said flange (18), and wherein said second outlet passage means further comprises said central opening (16) and a space defined between said cyclone (42) and said casing (40).

25. An oil filter as claimed in any one of claims 21 to 24, wherein said removal pipe (58) extends through said central opening (16).

26. An oil filter as claimed in claim 18, wherein said separator B further includes a base ring (148, 164) attached to the open end of said casing (40), and wherein said second outlet passage means comprises a central opening defined by said base ring (148, 164) and a space defined between said cyclone and said casing (40).

27. An oil filter as claimed in claim 26, wherein said removal pipe extends through said opening of said base ring (148, 164).

28. An oil filter as claimed in claim 26, wherein said base ring (148, 164) is secured at the inner periphery thereof to the mount (138), and wherein said attachment means comprises an inner end portion (132) of said base plate (130) defining said central opening, said inner end portion (132) being detachably secured to the mount.

29. An oil filter as claimed in claim 28, wherein said inner end portion (132) of said base plate (130) includes a threaded surface.

30. An oil filter as claimed in any one of claims 26 to 29, wherein said casing is attached to the outer surface of said base ring (148), and further comprising a seal member (154) fitted between said casing (40) and said end plate (140) of said filter element (26) closer to the open end of said housing.

31. An oil filter as claimed in any one of claims 26 to 29, wherein said casing (40) is attached to an inner surface of said base ring (164), and further comprising a seal member (172) fitted between said base ring (164) and said end plate (168) of said filter element closer to the open end of said housing.

32. An oil filter as claimed in any one of claims 26 to 31, wherein said base ring (148, 164) and said inner end portion (132) of said base plate (130) define an inlet passage (136) for the oil into said housing.

33. An oil filter as claimed in claim 18, wherein a base ring (108) attached to the open end of the casing (40) is fixedly securable at its inner periphery to the mount (112), and wherein said attachment means comprises an inner surface of said base plate (100) defining a central opening, said inner surface being detachably secured to the outer periphery of said base ring.

34. An oil filter as claimed in claim 33, wherein said inner surface of said base plate (100) is threadedly engaged with the outer periphery of said base ring (108).

35. An oil filter as claimed in claim 5, further comprising a centre bolt (212) for attaching said housing (210) to a mount (224) in an oil lubricating system, said centre bolt extending in said housing along an axis thereof, and wherein said first outlet passage means comprises a removal passage (258) formed in said centre bolt and orifices (260) formed in a portion of said centre bolt extending in said cyclone (242),

said orifices connecting said chamber (244) with said removal passage.

36. An oil filter as claimed in claim 35, wherein said second outlet passage means comprises a plurality of pores (254) formed in the wall of said cyclone, a space defined between said casing (240) and said cyclone and the open end of said casing.

37. An oil filter as claimed in any one of the preceding claims, further comprising an additional filter element (327) and additional end plates (329, 331) attached respectively to the ends of said additional filter element, said additional filter element being finer than said first-mentioned filter element (326).

38. An oil filter as claimed in claim 37 when appended to claim 9, wherein said filter element (326) and said additional filter element (327) are arranged end-to-end with one of said end plates (328) of said first-mentioned filter element (326) lying against one of said additional end plates (331) of said additional filter element (327), and wherein said second outlet passage means further comprises a pipe (334) extending along an axis of said additional filter element and communicating with said pores (354).

39. An oil filter as claimed in claim 38, wherein said first outlet passage means further includes an annular space (335) defined between said pipe (334) and an inner periphery of said additional filter element (327), said removal pipe (358) opening into said annular space.

40. An oil filter comprising:

a housing (310) open at one end thereof;

a first separator unit (A) disposed in said housing for removing solid contaminants from the oil introduced into said housing, said first separator unit including a cylindrical primary filter element (326) and a cylindrical secondary filter element (327) aligned with each other, said secondary filter element being finer than said primary filter element;

a second separator unit (B) for removing gaseous contaminants from the oil that has passed through said primary filter element, said second separator unit being accommodated entirely within the space defined by inner peripheries of said primary and secondary filter elements, said second separator unit including a chamber adapted to generate a vortical flow of the oil introduced therein to thereby separate gas-rich oil which gathers in an axially central portion of said chamber;

a first outlet passage means (337, 366) for discharging outside said housing said gas-rich oil and the oil that has passed through said secondary filter element; and

a second outlet passage means (364) for leading gas-lean oil outside said housing; said first and second outlet passage means extending into said housing from the open end thereof.

41. An oil filter as claimed in claim 40, wherein said first separator unit further comprises a pair of first end plates (328, 330) attached to said primary filter element (326) and a pair of second end plates (329, 331) attached to said secondary filter element (327), one (328) of said first end plates lying against one (331) of said second end plates.

42. An oil filter as claimed in claim 41, wherein said second separator unit (B) is disposed between said pair of first end plates (328, 330) and surrounded by the inner periphery of said primary filter element (326).

43. An oil filter as claimed in claim 42, wherein said second separator unit (B) further includes a cylindrical casing (340) closed at one end by an end wall and an open at the opposite end, a cyclone (342) secured in said casing for defining said chamber in cooperation with said end wall, and an inlet (348) formed in said casing for introducing the oil into said chamber along a tangential direction of said casing.

44. An oil filter as claimed in claim 43, wherein said second outlet passage means comprises a plurality of pores (354) formed in a wall of said cyclone, a space defined between said cyclone and said casing, said opening of said casing, and a pipe (334) connected to said opening and extending in the space defined by the inner periphery of said secondary filter element (327).

45. An oil filter as claimed in claim 44, wherein said first outlet passage means comprises a removal pipe (358) extending into said chamber along the axis of said cyclone and having formed in the wall thereof

a plurality of orifices (360) permitting the gas-rich oil to flow thereinto, and an annular space (335) defined between said pipe and the inner periphery of said secondary filter element, said removal pipe opening into said annular space.

46. An oil filter as claimed in claim 41, wherein said second separator unit (B) is disposed between said pair of second end plates (329, 331) and surrounded by the inner periphery of said secondary filter element (327).

47. An oil filter as claimed in claim 46, wherein said second separator unit further includes a substantially cylindrical casing (372) adapted to receive the oil that has passed through said primary element (326), a cyclone (374) secured in said casing for defining said chamber, and an inlet (378) for introducing the oil into said chamber.

48. An oil filter as claimed in claim 47, wherein said second outlet passage means comprises a plurality of pores formed in the wall of said cyclone (374) and the space between said cyclone and said casing.

49. An oil filter as claimed in claim 48, wherein said first outlet passage means comprises a removal pipe (358) extending into said chamber along the axis of said cyclone and having formed in the wall thereof a plurality of orifices for permitting the gas-rich oil to flow thereinto, and an annular space defined between said casing and the inner periphery of said secondary filter element, said removal pipe opening into said annular space.

Patentansprüche

1. Ölfilter, der zum Einbau in ein Schmiersystem geeignet ist, mit einem Gehäuse (10, 210; 310), einem entfernbar in dem Gehäuse angeordneten, zylindrischen Filterelement (26; 226; 326; 327) zum Entfernen fester Verunreinigungen, einer an jedem jeweiligen Ende des zylindrischen Filterelements befestigten Stirnplatte (28, 228, 328, 329; 30, 140, 168, 230, 330, 331) und einem innerhalb des durch den Innenumfang des zylindrischen Filterelements begrenzten Raums angeordneten Abscheider (B) zum Entfernen gasförmiger Verunreinigungen, dadurch gekennzeichnet, daß der Abscheider gänzlich innerhalb des durch den Innenumfang des Filterelements zwischen den Stirnplatten begrenzten Raums angeordnet ist.

2. Ölfilter nach Anspruch 1, wobei der Abscheider (B) zum Entfernen gasförmiger Verunreinigungen aus Öl ausgebildet ist, das durch das Filterelement (26, 226, 326) hindurchgeführt worden ist.

3. Ölfilter nach Anspruch 1 oder 2, wobei der Abscheider (B) eine Kammer (44, 244) aufweist, die zur Erzeugung einer Wirbelströmung des dort eingeführten Öls zum Aufteilen des Öls in gasreiches Öl und gasarmes Öl ausgebildet ist.

4. Ölfilter nach Anspruch 3, weiter mit einem ersten Auslaßdurchtrittsmittel (58, 258) für das gasreiche Öl und einem zweiten Auslaßdurchtrittsmittel (62, 120) für das gasarme Öl, wobei sich das erste und das zweite Auslaßdurchtrittsmittel in das Gehäuse durch ein offenes Ende desselben hinein erstrecken.

5. Ölfilter nach Anspruch 4, wobei der Abscheider (B) weiter ein zylindrisches Behältnis (40, 240) mit einem offenen Ende und einem durch eine Stirnwand (41) gebildeten, geschlossenen Ende, einem in dem Behältnis zur Begrenzung der Kammer (44, 244) in Zusammenarbeit mit der Stirnwand befestigten Zyklon (42, 72, 76, 244) und einem in dem Behältnis zum Einführen des Öls in die Kammer entlang einer tangentialen Richtung des Behältnisses ausgebildeten Einlaß (48, 80, 248).

6. Ölfilter nach Anspruch 5, wobei das zweite Auslaßdurchtrittsmittel eine Vielzahl von in einer den Zyklon begrenzenden Wand gebildeten Poren (54, 74, 82, 90, 254) aufweist.

7. Ölfilter nach Anspruch 6, wobei die Poren (90) nur in dem weiteren Endbereich und dem mittleren Bereich des Zyklons ausgebildet sind.

8. Ölfilter nach Anspruch 7, wobei die Poren (90) unterschiedliche Abmessungen aufweisen, die sich in Richtung auf den schmaleren Endbereich des Zyklons allmählich vergrößern.

9. Ölfilter nach irgendeinem der Ansprüche 5 bis 8, wobei das erste Auslaßdurchtrittsmittel ein Abführungsrohr (58) aufweist, das sich in die Kammer entlang der Achse des Zyklons erstreckt und in dessen Wand eine Vielzahl von Öffnungen (60) ausgebildet ist, damit das gasreiche Öl dort hineinfließen kann.

10. Ölfilter nach Anspruch 9, wobei ein Außendurchmesser des Abführungsrohrs (58) im Bereich von 15 % bis 36 % eines maximalen Innendurchmessers des weiteren Endbereichs des Zyklons liegt.

11. Ölfilter nach Anspruch 9 oder 10, wobei der Zyklon nach Art eines Trichters gestaltet ist, in dessen kleinerem Endbereich das Abführungsrohr sitzt.

12. Ölfilter nach irgendeinem der Ansprüche 5 bis 10, wobei der Zyklon (72) eine parabolische Gestalt in dem die Achse des Zyklons enthaltenden Längsschnitt aufweist.

13. Ölfilter nach irgendeinem der Ansprüche 5 bis 12, wobei die Stirnwand (41) des Behältnisses ein an einem zentralen Bereich desselben ausgebildeten konkaven Bereich (46) aufweist, der in die Kammer dem Einlaß (48) zugewandt vorsteht.

14. Ölfilter nach irgendeinem der Ansprüche 5 bis 13, wobei der Abscheider (B) weiter eine an der Innenfläche des Zyklons befestigte schraubenförmige Führungsplatte (78, 86) zur Intensivierung der Wirbelströmung des Öls aufweist.

15. Ölfilter nach Anspruch 14, wobei der Abscheider (B) weiter eine an der inneren Umfangsfläche der Führungsplatte (86) befestigte, dem Einlaß (80) zugewandte Säule (84) aufweist, wobei die Säule einen Durchmesser größer als ein Durchmesser des Abführungsrohrs (58) aufweist.

16. Ölfilter nach irgendeinem der Ansprüche 5 bis 15, wobei der Einlaß (48) durch Lochstanzen der Wand des Behältnisses ausgebildet ist, um einen sich im wesentlichen entlang einer Tangente des Behältnisses an dem Einlaß erstreckenden Ablenker (50) vorzusehen.

17. Ölfilter nach Anspruch 9, wobei das Abführungsrohr (58) ein Druckregelmittel (68) aufweist, wodurch das gasreiche Öl in dem Abführungsrohr von dort abgegeben werden kann, wenn ein Druck in dem Abführungsrohr einen vorbestimmten Wert überschreitet.

18. Ölfilter nach irgendeinem der Ansprüche 5 bis 17, weiter mit einer an dem Gehäuse an dem offenen Ende desselben befestigten Basisplatte (12, 100, 130), wobei die Basisplatte ein Befestigungsmittel (18, 108, 132) zur Befestigung des Gehäuses an einem Sockel (24, 112, 138) in einem Ölschmiersystem aufweist.

19. Ölfilter nach Anspruch 18, wobei die Basisplatte (12, 100) eine darin ausgebildete Öffnung (20) aufweist, damit das Öl in das Gehäuse fließen kann.

20. Ölfilter nach Anspruch 19, weiter mit einem in der Nähe der Öffnung (20) angeordneten Rückschlagventil (34) zur Verhinderung eines Rückfließens des Öls.

21. Ölfilter nach irgendeinem der Anspruch 18 bis 20, wobei die Basisplatte eine zentrale Öffnung (16) aufweist.

22. Ölfilter nach Anspruch 21, wobei das Befestigungsmittel einen an einem Innenumfang der die zentrale Öffnung (16) begrenzenden Basisplatte (12) ausgebildeten Flansch (18) aufweist.

23. Ölfilter nach Anspruch 22, wobei der Flansch (18) eine mit Gewinde ausgebildete Innenfläche (18a) aufweist.

24. Ölfilter nach Anspruch 22 oder 23, wobei sich die Stirnplatte (30) des Filterelements (26) näher an dem offenen Ende des Gehäuses einwärts erstreckt, um gegen die Außenfläche des Flanschs (18) anzuliegen, und wobei das zweite Auslaßdurchtrittsmittel weiter eine zentrale Öffnung (16) und einen zwischen dem Zyklon (42) und dem Behältnis (40) begrenzten Raum aufweist.

25. Ölfilter nach irgendeinem der Ansprüche 21 bis 24, wobei sich das Abführungsrohr (58) durch die zentrale Öffnung (16) hindurch erstreckt.

26. Ölfilter nach Anspruch 18, wobei der Abscheider (B) weiter einen an dem offenen Ende des Behältnisses (40) befestigten Basisring (148, 164) aufweist und wobei das zweite Auslaßdurchtrittsmittel eine durch den Basisring (148, 164) und einen zwischen dem Zyklon und dem Behältnis (40) begrenzten Raum begrenzt.

27. Ölfilter nach Anspruch 26, wobei sich das Abführungsrohr durch die Öffnung des Basisrings (148, 164) erstreckt.

28. Ölfilter nach Anspruch 26, wobei der Basisring (148, 164) an seinem Innenumfang an dem Sockel (138) befestigt ist und wobei das Befestigungsmittel einen inneren Endbereich (132) der die zentrale Öffnung begrenzenden Basisplatte (130) aufweist, wobei der innere Endbereich (132) an dem Sockel lösbar befestigt ist.

29. Ölfilter nach Anspruch 28, wobei der innere Endbereich (132) der Basisplatte (130) eine mit Gewinde ausgebildete Fläche aufweist.

30. Ölfilter nach irgendeinem der Ansprüche 26 bis 29, wobei das Behältnis an der Außenfläche des Basisrings (148) befestigt ist und weiter mit einem zwischen dem Behältnis (40) und der Stirnplatte (140) des Filterelements (26) näher dem offenen Ende des Gehäuses eingesetzten Abdichtteil (154).

31. Ölfilter nach irgendeinem der Ansprüche 26 bis 29, wobei das Behältnis (40) an einer Innenfläche des Basisrings (164) befestigt ist und weiter mit einem zwischen dem Basisring (164) und der Stirnplatte (168) des Filterelements näher an dem offenen Ende des Gehäuses eingesetzten Abdichtteil (172).

32. Ölfilter nach irgendeinem der Ansprüche 26 bis 31, wobei der Basisring (148, 164) und der innere Endbereich (132) der Basisplatte (130) einen Einlaßdurchtritt (136) für das Öl in das Gehäuse begrenzen.

33. Ölfilter nach Anspruch 18, wobei ein an dem offenen Ende des Behältnisses (40) befestigter Basisring (108) an seinem Innenumfang an dem Sockel (112) fest befestigbar ist und wobei das Befestigungsmittel eine Innenfläche der eine zentrale Öffnung begrenzenden Basisplatte (100) aufweist, wobei die Innenfläche an dem Außenumfang des Basisrings lösbar befestigt ist.

34. Ölfilter nach Anspruch 33, wobei die Innenfläche der Basisplatte (100) mit dem Außenumfang des Basisrings (108) über ein Gewinde im Eingriff steht.

35. Ölfilter nach Anspruch 5, weiter mit einem zentralen Schraubbolzen (212) zur Befestigung des Gehäuses (210) an einem Sockel (224) in einem Ölschmiersystem, wobei sich der zentrale Schraubbolzen in dem Gehäuse entlang einer Achse desselben erstreckt, und wobei das erste Auslaßdurchtrittsmittel einen in den zentralen Schraubbolzen ausgebildeten Abführungsdurchtritt (258) und in einem sich in dem Zyklon (242) erstreckenden Bereich des zentralen Schraubbolzens ausgebildete Öffnungen (260) aufweist, wobei die Öffnungen die Kammer (244) mit dem Abführungsdurchtritt verbinden.

36. Ölfilter nach Anspruch 35, wobei das zweite Auslaßdurchtrittsmittel eine Vielzahl von in der Wand des Zyklons ausgebildete Poren (254) und einen zwischen dem Behältnis (240) und dem Zyklon und dem offenen Ende des Behältnisses begrenzten Raum aufweist.

37. Ölfilter nach irgendeinem der vorhergehenden Ansprüche, weiter mit einem zusätzlichen Filterelement (327) und zusätzlichen Stirnplatten (329, 331), die jeweils an den Enden des zusätzlichen Filterelements befestigt sind, wobei das zusätzliche Filterelement feiner als das erstgenannte Filterelement (326) ist.

38. Ölfilter nach Anspruch 37 bei Abhängigkeit von Anspruch 9, wobei das Filterelement (326) und das zusätzliche Filterelement (327) in endseitiger Beziehung mit einer der Stirnplatten (328) des erstgenannten Filterelements (326) angeordnet sind, die gegen eine der zusätzlichen Stirnplatten (331) des

zusätzlichen Filterelements (327) anliegen, und wobei das zweite Auslaßdurchtrittsmittel ein sich entlang einer Achse des zusätzlichen Filterelements erstreckendes und mit den Poren (354) in Verbindung stehendes Rohr (334) aufweist.

39. Ölfilter nach Anspruch 38, wobei das erste Auslaßdurchtrittsmittel weiter einen zwischen dem Rohr (334) und dem Innenumfang des zusätzlichen Filterelements (327) begrenzten Ringraum (335) aufweist, wobei das Abführungsrohr (358) in den Ringraum mündet.

40. Ölfilter mit
einem an einem Ende offenen Gehäuse (310),
einer in dem Gehäuse zum Entfernen von festen Verunreinigungen aus dem in das Gehäuse eingeführten Öl angeordneten ersten Abscheidereinheit (A), wobei die erste Abscheidereinheit ein zylindrisches Primärfilterelement (326) und ein zylindrisches Sekundärfilterelement (327) aufweist, die miteinander fluchten, wobei das Sekundärfilterelement feiner als das Primärfilterelement ist,
einer zweiten Abscheidereinheit (B) zum Entfernen von gasförmigen Verunreinigungen aus dem Öl, das durch das Primärfilterelement hindurchgeführt worden ist, wobei die zweite Abscheidereinheit insgesamt innerhalb des durch die Innenumfänge der primären und sekundären Filterelemente begrenzten Raums aufgenommen ist, die zweite Abscheidereinheit eine Kammer aufweist, die zur Erzeugung einer Wirbelströmung des dort hinein eingeführten Öls ausgebildet ist, um dadurch gasreiches Öl abzuscheiden, das sich in einem axial zentralen Bereich der Kammer sammelt,
einem ersten Auslaßdurchstrittsmittel (337, 366) zum Abführen des gasreichen Öls und des Öls, das durch das Sekundärfilterelement hindurchgeführt worden ist, aus dem Gehäuse heraus und
einem zweiten Auslaßdurchtrittsmittel (364) zum Herausführen des gasarmen Öls aus dem Gehäuse,
wobei sich das erste und das zweite Auslaßdurchtrittsmittel von dem offenen Ende des Gehäuses in dieses hinein erstrekken.

41. Ölfilter nach Anspruch 40, wobei die erste Abscheidereinheit ein Paar von an dem Primärfilterelement (326) befestigten ersten Stirnplatten (328, 330) und ein Paar von an dem Sekundärfilterelement (327) befestigten zweiten Stirnplatten (329, 331) aufweist, wobei eine (328) der ersten Stirnplatten gegen eine (331) der zweiten Stirnplatten anliegt.

42. Ölfilter nach Anspruch 41, wobei die zweite Abscheidereinheit (B) zwischen dem Paar erster Stirnplatten (328, 330) angeordnet und von dem Innenumfang des Primärfilterelements (326) umgeben ist.

43. Ölfilter nach Anspruch 42, wobei die zweite Abscheidereinheit (B) weiter ein an einem Ende durch eine Stirnwand verschlossenes und an dem gegenüberliegenden Ende offenes, zylindrisches Behältnis (340), einen in dem Behältnis zur Begrenzung der Kammer in Zusammenarbeit mit der Stirnwand befestigten Zyklon (342) und einen in dem Behältnis zum Einführen des Öls in die Kammer längs einer tangentialen Richtung des Behältnisses ausgebildeten Einlaß (348) aufweist.

44. Ölfilter nach Anspruch 43, wobei das zweite Auslaßdurchtrittsmittel eine Vielzahl von in einer Wand des Zyklons ausgebildeten Poren (354), einen zwischen dem Zyklon und dem Behältnis und der Öffnung des Behältnisses begrenzten Raum und ein an die Öffnung angeschlossenes und sich in dem durch den Innenumfang des Sekundärfilterelements (327) begrenzten Raum erstreckendes Rohr (334) aufweist.

45. Ölfilter nach Anspruch 44, wobei das erste Auslaßdurchtrittsmittel ein sich in die Kammer entlang der Achse des Zyklons erstreckendes Abführungsrohr (358) mit einer in der Wand desselben ausgebildeten Vielzahl von Öffnungen (360), damit das gasreiche Öl dort hineinfließen kann, und einen zwischen dem Rohr und dem Innenumfang des Sekundärtfilterelements begrenzten Ringraum (335) aufweist, wobei das Abführungsrohr in den Ringraum mündet.

46. Ölfilter nach Anspruch 41, wobei die zweite Abscheidereinheit (B) zwischen dem Paar zweiter Stirnplatten (329, 331) angeordnet und von dem Innenumfang des Sekundärfilterelements (327) umgeben ist.

47. Ölfilter nach Anspruch 46, wobei die zweite Abscheidereinheit weiter ein im wesentlichen zylindrisches Behältnis (372), das zur Aufnahme des durch das Primärelement (326) hindurchgeführten Öls bestimmt ist, einen in dem Behältnis zur Begrenzung der Kammer befestigten Zyklon (374) und einen Einlaß

(378) zur Einführung des Öls in die Kammer aufweist.

48. Ölfilter nach Anspruch 47, wobei das zweite Auslaßaustrittsmittel eine Vielzahl von in der Wand des Zyklons (374) ausgebildeten Poren und den Raum zwischen dem Zyklon und dem Behältnis aufweist.

49. Ölfilter nach Anspruch 48, wobei das erste Auslaßdurchtrittsmittel ein sich in die Kammer entlang der Achse des Zyklons erstreckendes Abführungsrohr (358) mit einer in der Wand desselben ausgebildeten Vielzahl von Öffnungen, damit das gasreiche Öl dort hineinfließen kann, und einen zwischen dem Behältnis und dem Innenumfang des Sekundärfilterelements begrenzten Ringraum aufweist, wobei das Abführungsrohr in den Ringraum mündet.

Revendications

1. Filtre à huile pouvant être intégré dans un système de graissage, comprenant un boîtier (10 ; 210 ; 310), un élément filtrant cylindrique (26 ; 226 ; 326 ; 327) pour enlever les polluants solides monté de manière amovible dans ledit boîtier, une plaque d'extrémité (28, 228, 328, 329 ; 30, 140, 168, 230, 330, 331) fixée à chaque extrémité respective dudit élément filtrant cylindrique, et un séparateur (B) pour éliminer les polluants gazeux placé dans l'espace défini par la périphérie intérieure de l'élément filtrant cylindrique, caractérisé en ce que ledit séparateur est placé entièrement dans l'espace défini par la périphérie intérieure de l'élément filtrant entre lesdites plaques d'extrémité.

2. Filtre à huile selon la revendication 1, dans lequel ledit séparateur (B) est conçu pour enlever les polluants gazeux de l'huile qui a traversé ledit élément filtrant (26, 226, 326).

3. Filtre à huile selon la revendication 1 ou 2, dans lequel ledit séparateur (B) inclut une chambre (44, 244) conçue pour créer un écoulement rotationnel de l'huile introduite à l'intérieur pour séparer l'huile en huile riche en gaz et huile pauvre en gaz.

4. Filtre à huile selon la revendication 3, comprenant également un premier moyen de passage de sortie (58, 128) pour ladite huile riche en gaz et un deuxième moyen de passage de sortie (62, 120) pour ladite huile pauvre en gaz, lesdits premiers et deuxièmes moyens de passage de sortie s'étendant à l'intérieur dudit boîtier par l'une de ses extrémités ouvertes.

5. Filtre à huile selon la revendication 4, dans lequel ledit séparateur (B) inclut également un carter cylindrique (40, 240) ayant une extrémité ouverte et une extrémité fermée formée par une paroi d'extrémité (41), un cyclone (42, 72, 76, 242) fixé dans ledit carter pour définir ladite chambre (44, 244) en association avec ladite paroi d'extrémité, et une entrée (48, 80, 248) formée dans le carter pour introduire l'huile dans ladite chambre le long d'une direction tangentielle dudit carter.

6. Filtre à huile selon la revendication 5, dans lequel ledit deuxième moyen de passage de sortie comprend une pluralité de pores (54, 74, 82, 90, 254) formés dans une paroi définissant ledit cyclone.

7. Filtre à huile selon la revendication 6, dans lequel lesdits pores (90) sont formés seulement dans la partie d'extrémité plus large et la partie intermédiaire dudit cyclone.

8. Filtre à huile selon la revendication 7, dans lequel lesdits pores (90) ont des dimensions variables, qui vont en s'élargissant progressivement vers la partie d'extrémité plus étroite dudit cyclone.

9. Filtre à huile selon l'une quelconque des revendications 5 à 8, dans lequel lesdits premiers moyens de passage de sortie comprennent un tuyau d'évacuation (58) s'étendant à l'intérieur de ladite chambre le long de l'axe dudit cyclone et présentant dans sa paroi une pluralité d'orifices (60) pour permettre à l'huile riche en gaz d'y pénétrer.

10. Filtre à huile selon la revendication 9, dans lequel un diamètre extérieur dudit tuyau d'évacuation (58) se situe dans la plage allant de 15 % à 35 % d'un diamètre intérieur maximal au niveau de la partie d'extrémité plus large dudit cyclone.

11. Filtre à huile selon la revendication 9 ou 10, dans lequel ledit cyclone est en entonnoir, ledit tuyau d'évacuation étant placé dans sa partie d'extrémité plus petite.

12. Filtre à huile selon l'une quelconque des revendications 5 à 10, dans lequel ledit cyclone (72) a une forme parabolique en section transversale longitudinale contenant l'axe dudit cyclone.

13. Filtre à huile selon l'une quelconque des revendications 5 à 12, dans lequel ladite paroi d'extrémité (41) dudit carter présente sur une de ses parties centrales une partie concave (46) dépassant à l'intérieur de ladite chambre pour faire face à ladite entrée (48).

14. Filtre à huile selon l'une quelconque des revendications 5 à 13, dans lequel ledit séparateur (B) comprend également une plaque de guidage hélicoïdale (78, 86) attachée à la surface intérieure dudit cyclone pour intensifier l'écoulement rotationnel de l'huile.

15. Filtre à huile selon la revendication 14, dans lequel ledit séparateur (B) comprend également une colonne (84) attachée à la surface périphérique intérieure de ladite plaque de guidage (86) pour faire face à ladite entrée (80), ladite colonne ayant un diamètre plus grand qu'un diamètre dudit tuyau d'évacuation (58).

16. Filtre à huile selon l'une quelconque des revendications 5 à 15, dans lequel ladite entrée (48) est formée par compression par poinçon de la paroi dudit carter pour fournir un déflecteur (50) s'étendant essentiellement le long d'une tangente dudit carter au niveau de ladite entrée.

17. Filtre à huile selon la revendication 9, dans lequel ledit tuyau d'évacuation (58) est pourvu d'un moyen de contrôle de la pression (68), permettant de décharger l'huile riche en gaz dudit tuyau d'évacuation lorsqu'une pression à l'intérieur dudit tuyau d'évacuation excède une valeur prédéterminée.

18. Filtre à huile selon l'une quelconque des revendications 5 à 17, comprenant également une plaque d'appui (12, 100, 130) fixée audit boîtier à son extrémité ouverte, ladite plaque d'appui incluant des moyens de fixation (18, 108, 132) pour attacher ledit boîtier à un support (24, 112, 138) dans un système de graissage à huile.

19. Filtre à huile selon la revendication 18, dans lequel ladite plaque d'appui (12, 100) présente une ouverture (20) permettant à l'huile de pénétrer dans ledit boîtier.

20. Filtre à huile selon l'une quelconque des revendications 19, comprenant également une soupape de retenue (34) disposée à côté de ladite ouverture (20) pour éviter un écoulement inversé de l'huile.

21. Filtre à huile selon l'une quelconque des revendications 18 à 20, dans lequel ladite plaque d'appui présente une ouverture centrale (16).

22. Filtre à huile selon la revendication 21, dans lequel ledit moyen de fixation comprend une bride (18) formée sur une périphérie intérieure de ladite plaque d'appui (12) définissant ladite ouverture centrale (16).

23. Filtre à huile selon la revendication 22, dans lequel ladite bride (18) présente une surface intérieure filetée (18a).

24. Filtre à huile selon la revendication 22 ou 23, dans lequel ladite plaque d'extrémité (30) dudit élément filtrant (26) plus près de l'extrémité ouverte dudit boîtier s'étend vers l'intérieur pour buter contre la surface extérieure de ladite bride (18), et dans lequel ledit deuxième moyen de passage de sortie comprend également ladite ouverture centrale (16) et un espace défini entre ledit cyclone (42) et ledit carter (40).

25. Filtre à huile selon l'une quelconque des revendications 21 à 24, dans lequel ledit tuyau d'évacuation (58) traverse ladite ouverture centrale (16).

26. Filtre à huile selon la revendication 18, dans lequel ledit séparateur (B) inclut également une bague d'appui (148, 164) fixée à l'extrémité ouverte dudit carter (40), et dans lequel ledit deuxième moyen de passage de sortie comprend une ouverture centrale définie par ladite bague d'appui (148, 164) et un espace défini entre ledit cyclone et ledit carter (40).

27. Filtre à huile selon la revendication 26, dans lequel ledit tuyau d'évacuation traverse ladite ouverture de ladite bague d'appui (148, 164).

28. Filtre à huile selon la revendication 26, dans lequel ladite bague d'appui (148, 164) est fixée à sa périphérie intérieure au support (138), et dans lequel ledit moyen de fixation comprend une partie d'extrémité intérieure (132) de ladite plaque d'appui (130) définissant ladite ouverture centrale, ladite partie d'extrémité intérieure (132) étant fixée de manière détachable au support.

29. Filtre à huile selon la revendication 28, dans lequel ladite partie d'extrémité intérieure (132) de ladite plaque d'appui (130) inclut une surface filetée.

30. Filtre à huile selon l'une quelconque des revendications 26 à 29, dans lequel ledit carter est fixé à la surface extérieure de ladite bague d'appui (148), et comprenant également un élément d'étanchéité (154) placé entre ledit carter (40) et ladite plaque d'extrémité (140) dudit élément filtrant (26) plus près de l'extrémité ouverte dudit boîtier.

31. Filtre à huile selon l'une quelconque des revendications 26 à 29, dans lequel ledit carter (40) est fixé à une surface intérieure de ladite bague d'appui (164), et comprenant également un membre d'étanchéité (172) placé entre ladite bague d'appui (164) et ladite plaque d'extrémité (168) dudit élément filtrant plus près de l'extrémité ouverte dudit boîtier.

32. Filtre à huile selon l'une quelconque des revendications 26 à 31, dans lequel ladite bague d'appui (148, 164) et ladite partie d'extrémité intérieure (132) de ladite plaque d'appui (130) définissent un passage d'entrée (136) pour l'huile dans ledit boîtier.

33. Filtre à huile selon la revendication 18, dans lequel une bague d'appui (108) attachée à l'extrémité ouverte du carter (40) peut être attachée de manière fixe à sa périphérie intérieure au support (112), et dans lequel ledit moyen de fixation comprend une surface intérieure de ladite plaque d'appui (100) définissant une ouverture centrale, ladite surface intérieure étant fixée de manière détachable à la périphérie extérieure de ladite bague d'appui.

34. Filtre à huile selon la revendication 33, dans lequel ladite surface intérieure de ladite plaque d'appui (100) est engrenée de manière filetée avec la périphérie extérieure de ladite bague d'appui (108).

35. Filtre à huile selon la revendication 5, comprenant également un boulon central (212) pour fixer ledit boîtier (210) à un support (224) dans un système de graissage à huile, ledit boulon central s'étendant dans ledit boîtier le long d'un de ses axes, et dans lequel ledit premier moyens de passage de sortie comprend un passage d'évacuation (258) formé dans ledit boulon central et des orifices (260) formés dans une partie dudit boulon central s'étendant dans ledit cyclone (242), lesdits orifices reliant ladite chambre (244) audit passage d'évacuation.

36. Filtre à huile selon la revendication 35, dans lequel ledit deuxième moyen de passage de sortie comprend une pluralité de pores (254) formés dans la paroi dudit cyclone, un espace défini entre ledit carter (240) et ledit cyclone et l'extrémité ouverte dudit carter.

37. Filtre à huile selon l'une quelconque des revendications précédentes, comprenant également un élément filtrant supplémentaire (327) et des plaques d'extrémité supplémentaires (329, 331) fixées respectivement aux extrémités dudit élément filtrant supplémentaire, ledit élément filtrant supplémentaire étant plus fin que ledit élément filtrant mentionné en premier (326).

38. Filtre à huile selon la revendication 37, lorsqu'elle est annexée à la revendication 9, dans lequel ledit élément filtrant (326) et ledit élément filtrant supplémentaire (327) sont disposés côte à côte avec l'une desdites plaques d'extrémité (329) dudit élément filtrant mentionné en premier (326) étant placée

contre l'une desdites plaques d'extrémité supplémentaires (331) dudit élément filtrant supplémentaire (327), et dans lequel lesdits deuxièmes moyens de passage de sortie comprennent également un tuyau (334) s'étendant le long d'un axe dudit élément filtrant supplémentaire et communiquant avec lesdits pores (354).

39. Filtre à huile selon la revendication 38, dans lequel ledit premier moyen de passage de sortie inclut également un espace annulaire (335) défini entre ledit tuyau (334) et une périphérie intérieure dudit élément filtrant supplémentaire (327), ledit tuyau d'évacuation (358) s'ouvrant dans ledit espace annulaire.

40. Filtre à huile comprenant :

un boîtier (310) ouvert à l'une de ses extrémités ;

une première unité de séparateur (A) placée dans ledit boîtier pour enlever les polluants solides de l'huile introduite dans ledit boîtier, ladite première unité de séparateur incluant un élément filtrant primaire cylindrique (326) et un élément filtrant secondaire cylindrique (327) alignés l'un sur l'autre, ledit élément filtrant secondaire étant plus fin que ledit élément filtrant primaire ;

une deuxième unité de séparateur (B) pour enlever les polluants gazeux de l'huile qui a traversé ledit élément filtrant primaire, ladite deuxième unité de séparateur étant entièrement logée dans l'espace défini par les périphéries intérieures desdits éléments filtrants primaire et secondaire, ladite deuxième unité de séparateur incluant une chambre conçue pour générer un écoulement rotationnel de l'huile introduite à l'intérieur pour séparer ainsi l'huile riche en gaz qui se rassemble dans une partie axialement centrale de ladite chambre ;

un premier moyen de passage de sortie (337, 366) pour décharger à l'extérieur dudit boitier l'huile riche en gaz et l'huile qui a traversé ledit élément filtrant secondaire; et

un deuxième moyen de passage de sortie (364) pour guider l'huile pauvre en gaz hors dudit boîtier ;

lesdits premier et deuxième moyens de passage de sortie s'étendant à l'intérieur dudit boîtier par ladite extrémité ouverte de ce dernier.

41. Filtre à huile selon la revendication 40, dans lequel ladite première unité de séparateur comprend également une paire de premières plaques d'extrémité (328, 330) attachées audit élément filtrant primaire (326) et une paire de deuxièmes plaques d'extrémité (329, 331) attachées audit élément filtrant secondaire (327), l'une (328) desdites premières plaques d'extrémité étant placée contre l'une (331) desdites deuxièmes plaques d'extrémité.

42. Filtre à huile selon la revendication 41, dans lequel ladite deuxième unité de séparateur (B) est placée entre ladite paire de premières plaques d'extrémité (328, 330) et entourée par la périphérie intérieure dudit élément filtrant primaire (326).

43. Filtre à huile selon la revendication 42, dans lequel ladite deuxième unité de séparateur (B) inclut également un carter cylindrique (340) fermé à une extrémité par un mur d'extrémité et ouvert à l'extrémité opposée, un cyclone (342) placé dans ledit carter pour définir ladite chambre en association avec ladite paroi d'extrémité, et une entrée (348) formée dans ledit carter pour introduire l'huile dans ladite chambre le long d'une direction tangentielle dudit carter.

44. Filtre à huile selon la revendication 43, dans lequel ledit deuxième moyen de passage de sortie comprend une pluralité de pores (354) formés dans une paroi dudit cyclone, un espace défini entre ledit cyclone et ledit carter, ladite ouverture dudit carter, et un tuyau (334) relié à ladite ouverture et s'étendant dans l'espace défini par la périphérie intérieure dudit élément filtrant secondaire (327).

45. Filtre à huile selon la revendication 44, dans lequel ledit premier moyen de passage de sortie comprend un tuyau d'évacuation (358) s'étendant dans ladite chambre le long de l'axe dudit cyclone et présentant dans sa paroi une pluralité d'orifices (360) pour permettre à l'huile riche en gaz d'y pénétrer, un espace annulaire (335) défini entre ledit tuyau et la périphérie intérieure dudit élément filtrant secondaire, ledit tuyau d'évacuation s'ouvrant dans ledit espace annulaire.

46. Filtre à huile selon la revendication 41, dans lequel ladite deuxième unité de séparateur (B) est placée entre ladite paire de deuxièmes plaques d'extrémité (329, 331) et entourée d'une périphérie intérieure

dudit élément filtrant secondaire (327).

47. Filtre à huile selon la revendication 46, dans lequel ladite deuxième unité de séparateur inclut également un carter essentiellement cylindrique (372) adapté pour recevoir l'huile qui a traversé ledit élément primaire (326), un cyclone (374) installé dans ledit carter pour définir ladite chambre, et une entrée (378) pour introduire l'huile dans ladite chambre.

48. Filtre à huile selon la revendication 47, dans lequel ledit deuxième moyen de passage de sortie comprend une pluralité de pores formés dans la paroi dudit cyclone (374) et l'espace entre ledit cyclone et ledit carter.

49. Filtre à huile selon la revendication 48, dans lequel ledit premier moyen de passage de sortie comprend un tuyau d'évacuation (358) s'étendant dans ladite chambre le long de l'axe dudit cyclone et présentant dans sa paroi une pluralité d'orifices pour permettre à l'huile riche en gaz d'y pénétrer, et un espace annulaire défini entre ledit carter et ladite périphérie intérieure dudit élément filtrant secondaire, ledit tuyau d'évacuation s'ouvrant dans ledit espace annulaire.

FIG. 1

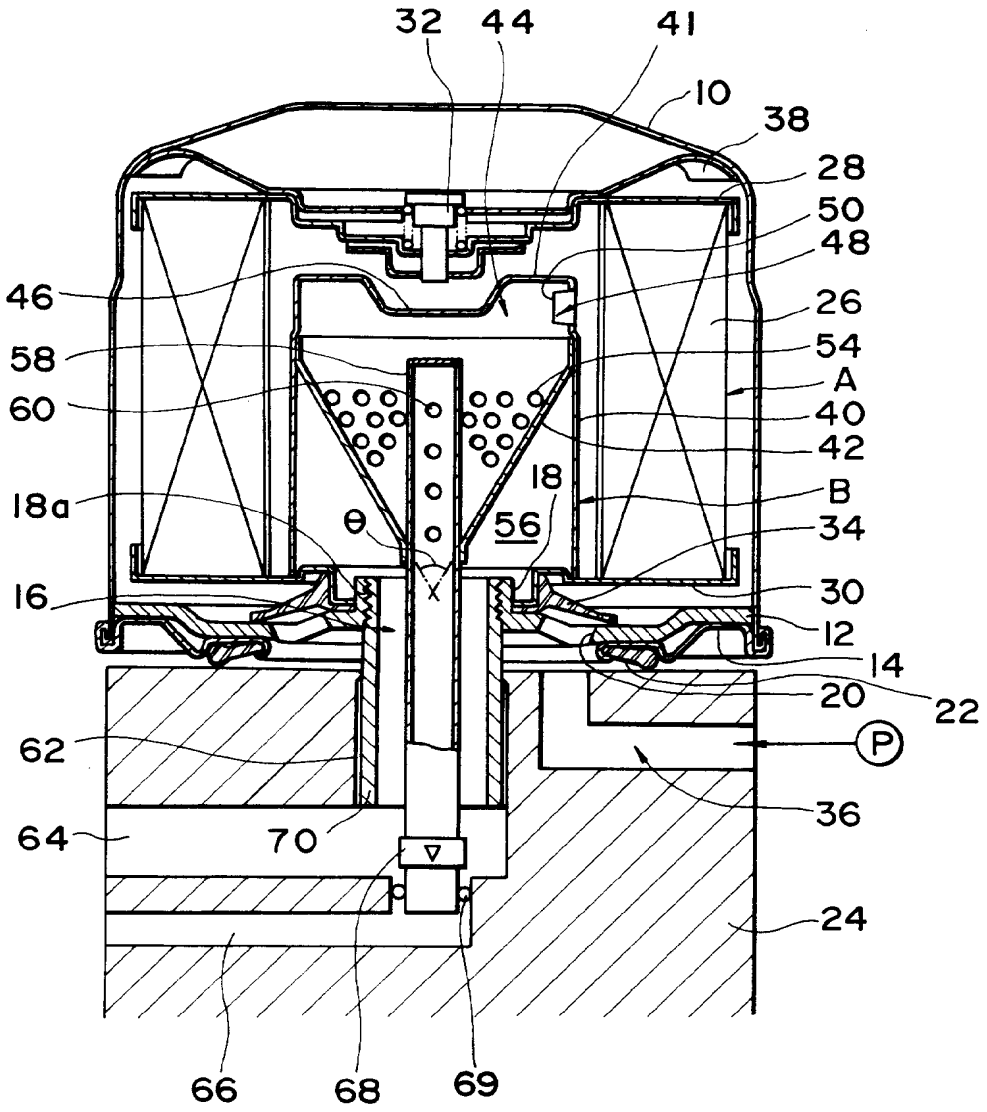
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FIG. 2

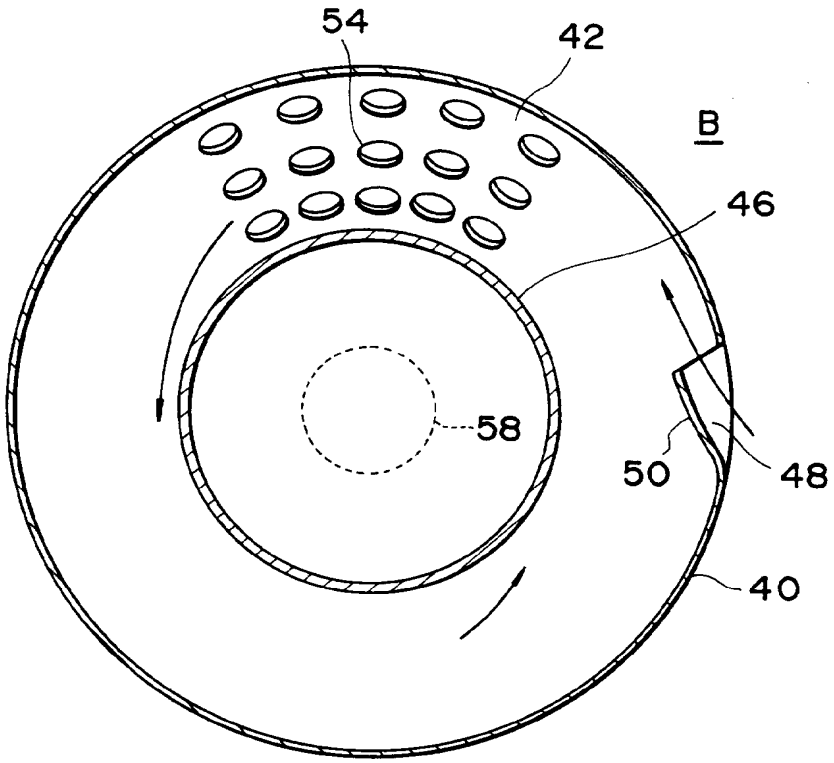


FIG. 3

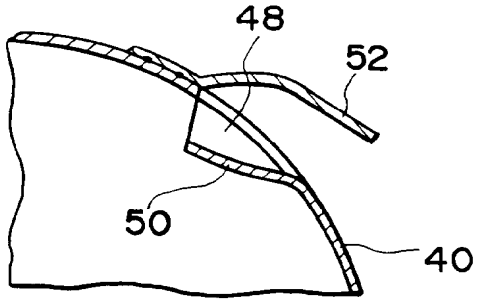


FIG. 4

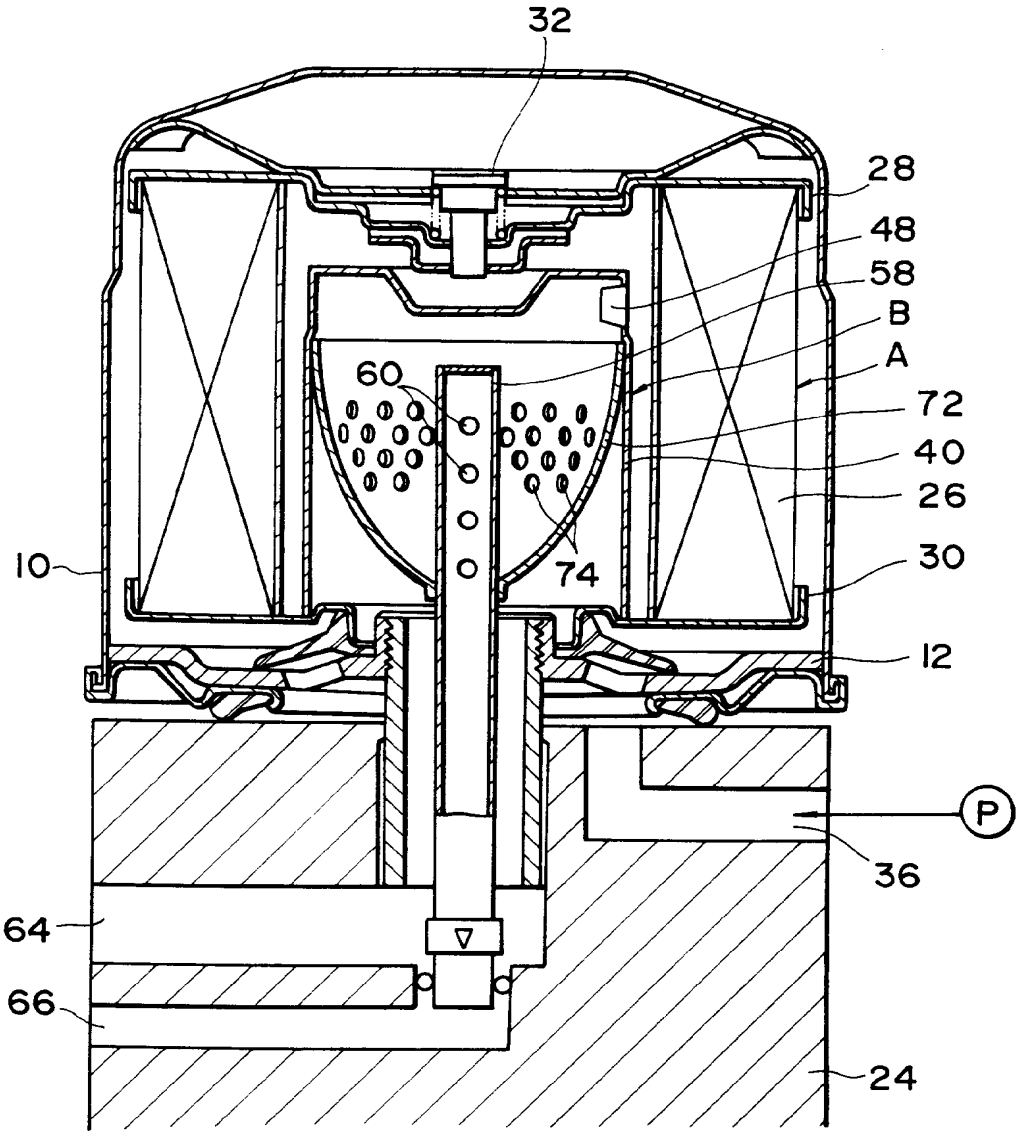


FIG. 5 (A)

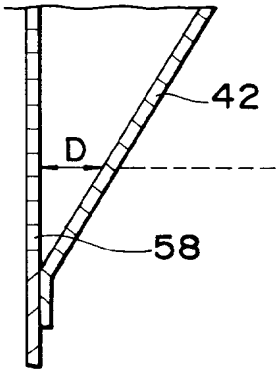


FIG. 5 (B)

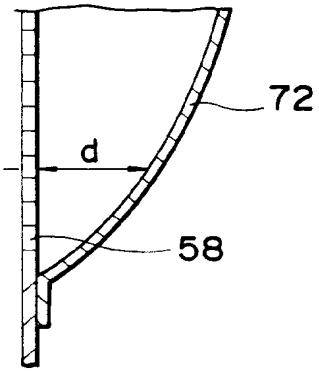


FIG. 7

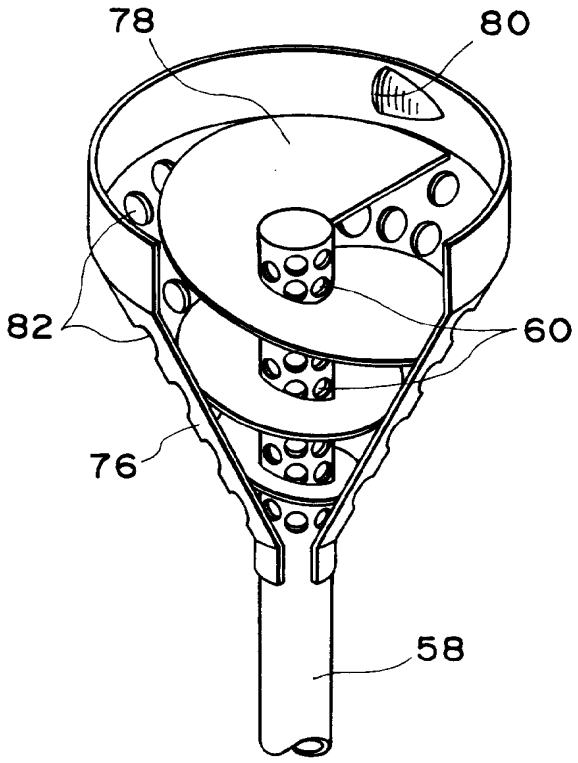


FIG. 8

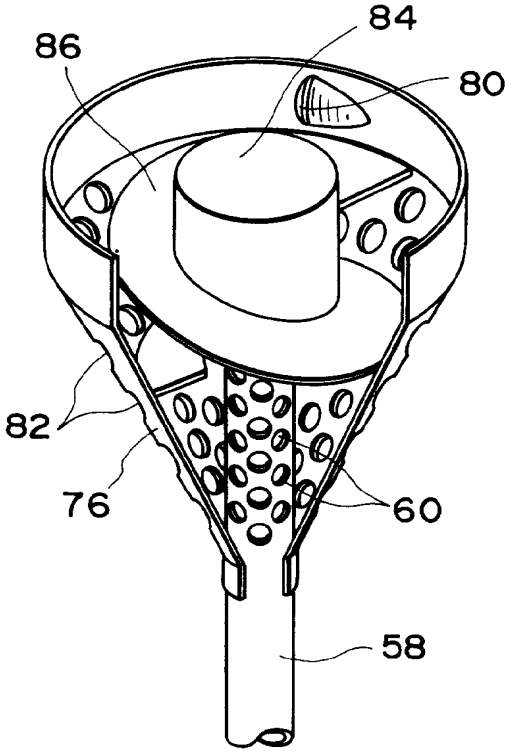


FIG. 6

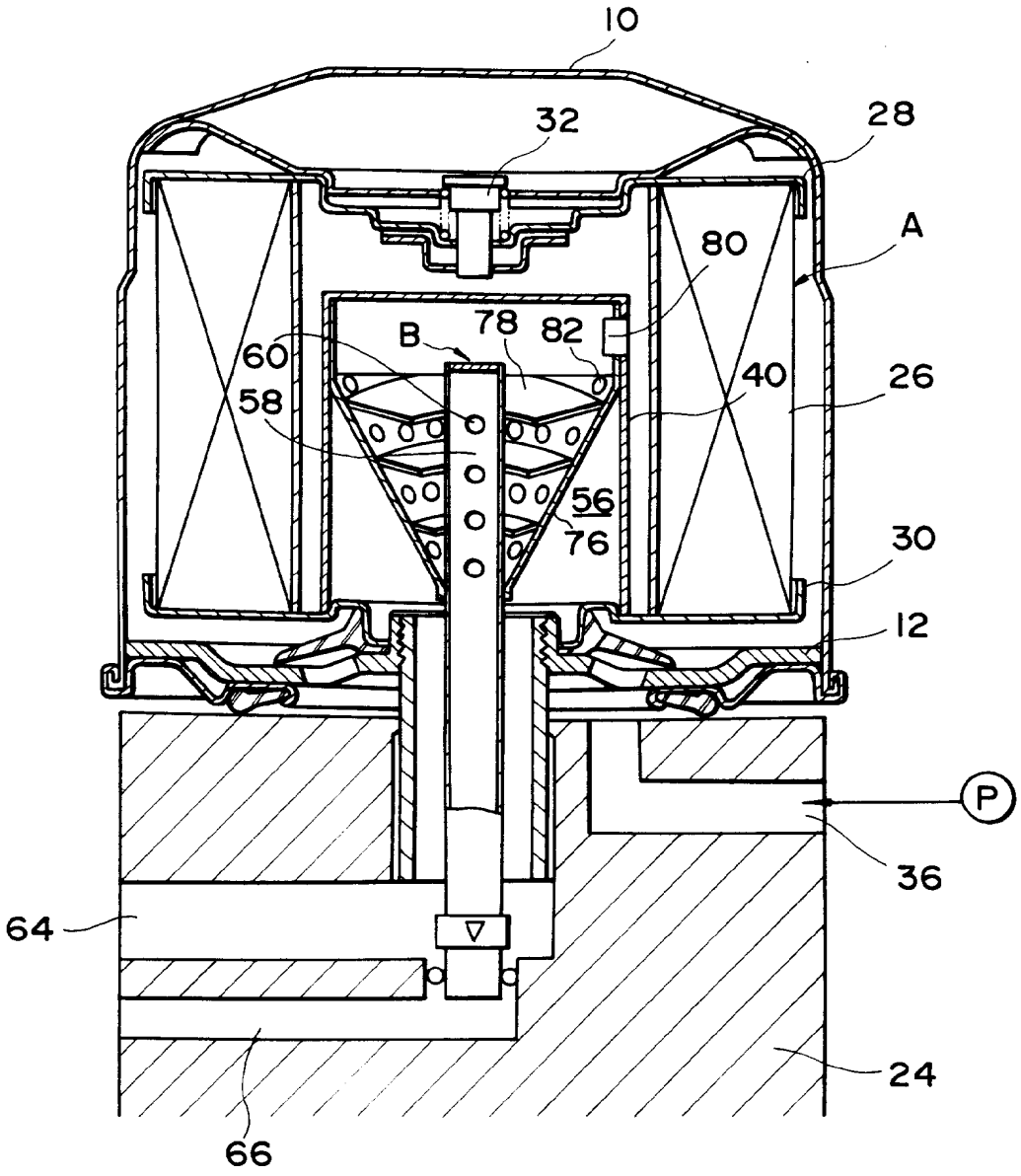


FIG. 9

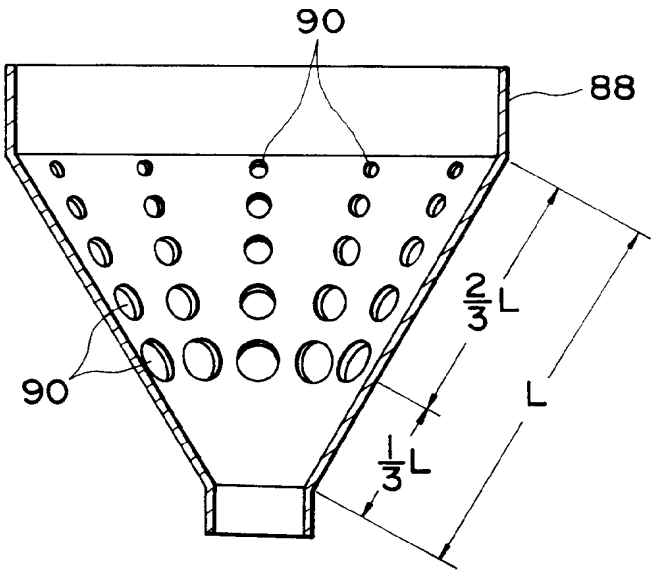


FIG. 10

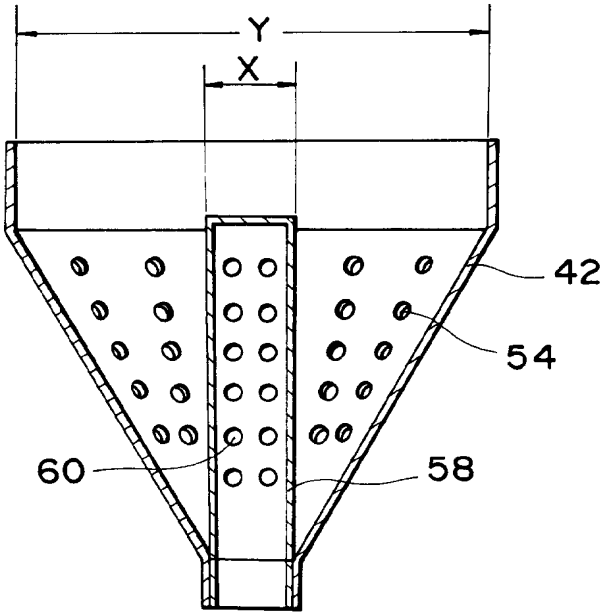
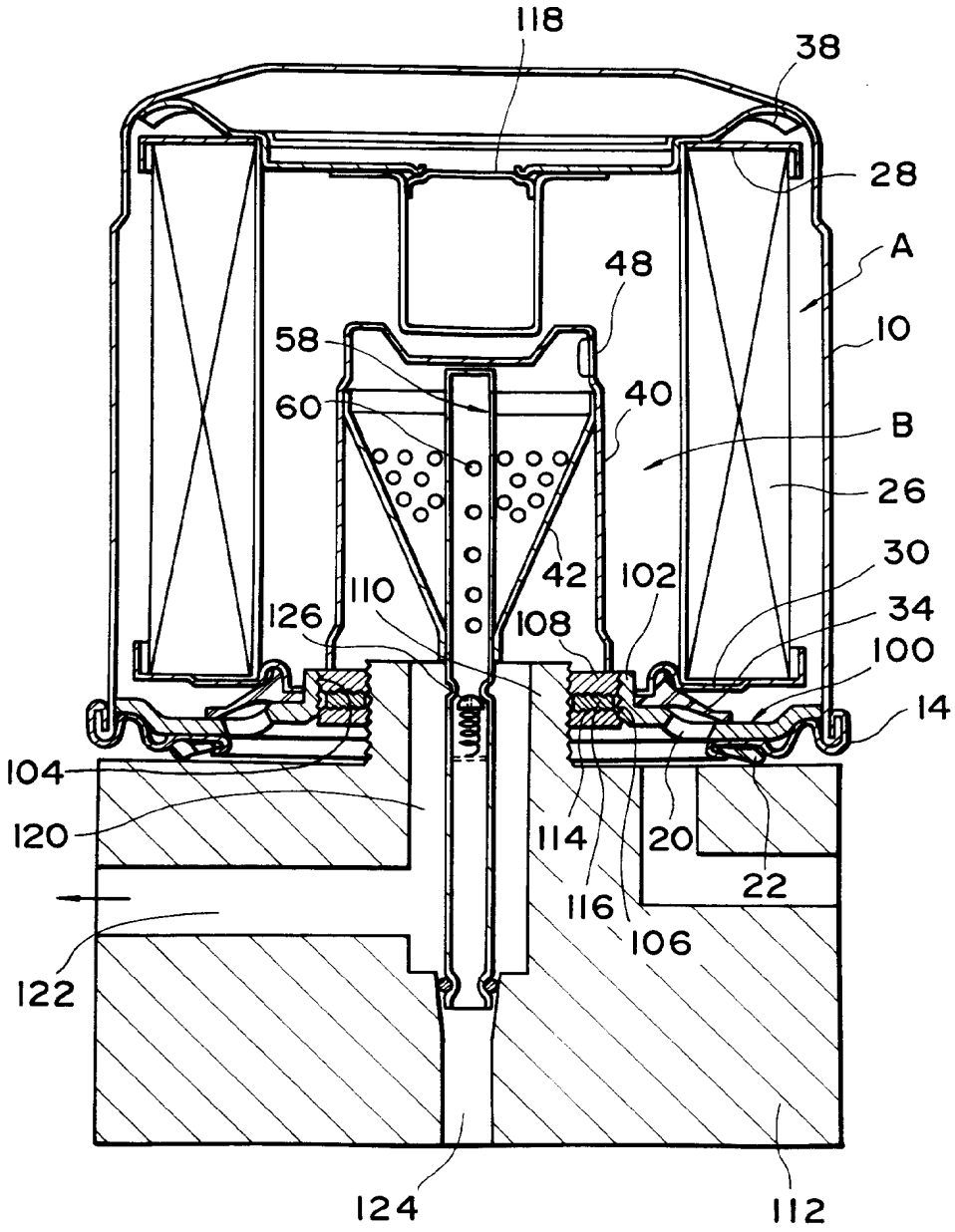


FIG. 11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122
124
112

FIG. 12

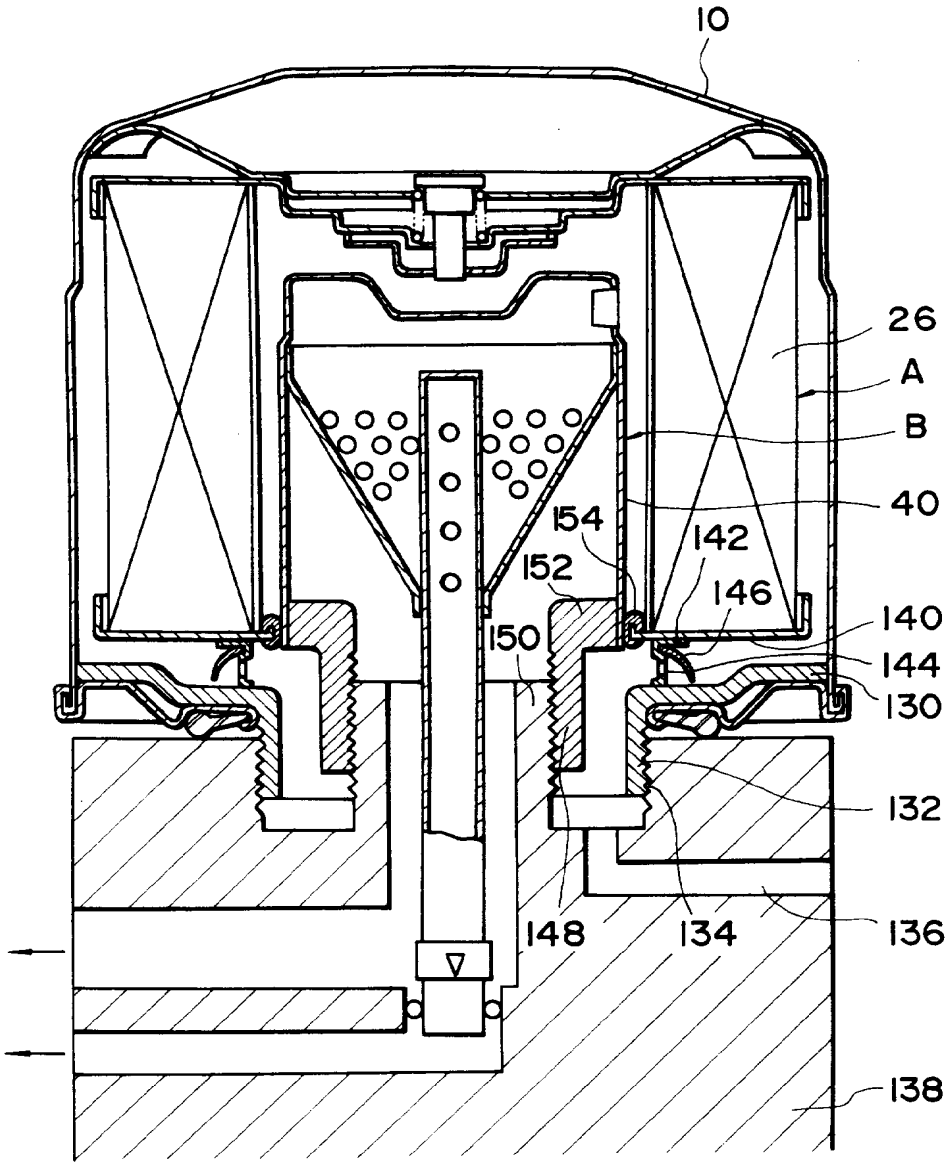


FIG. 13

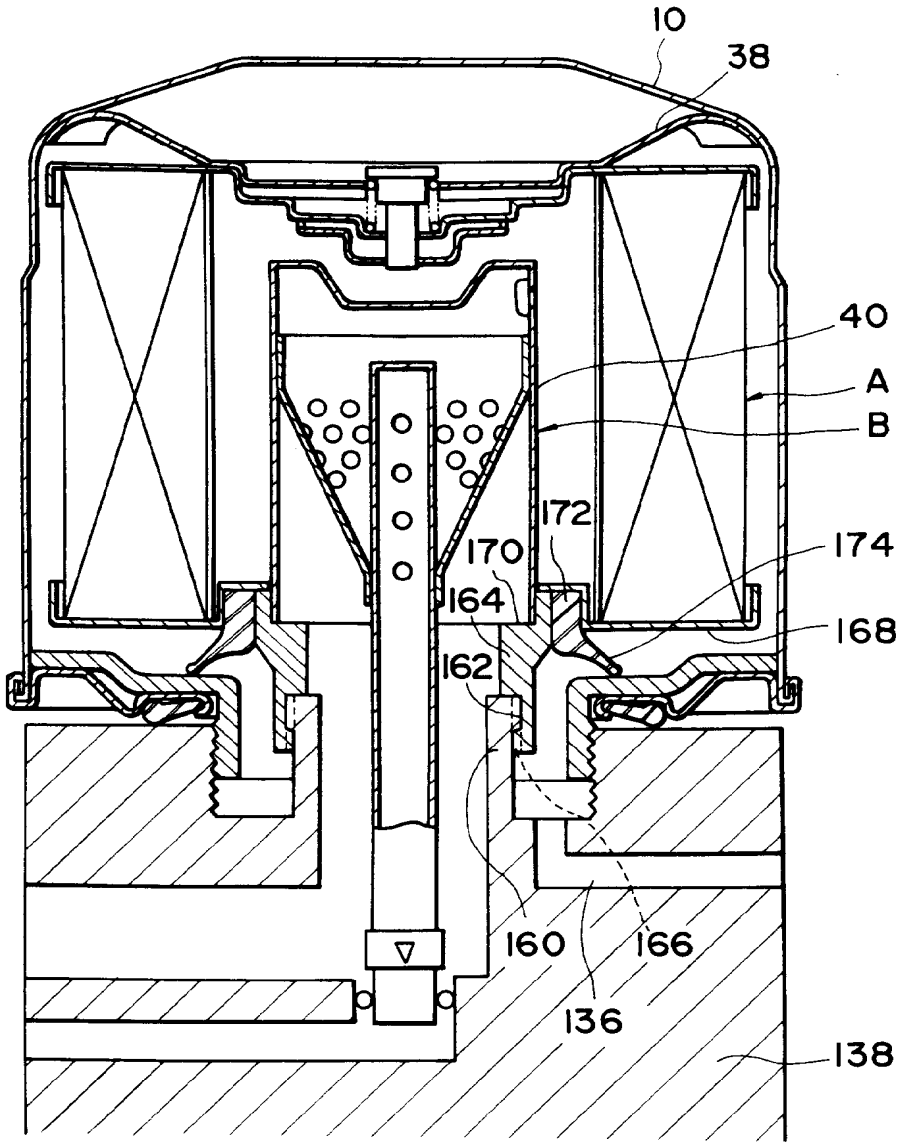
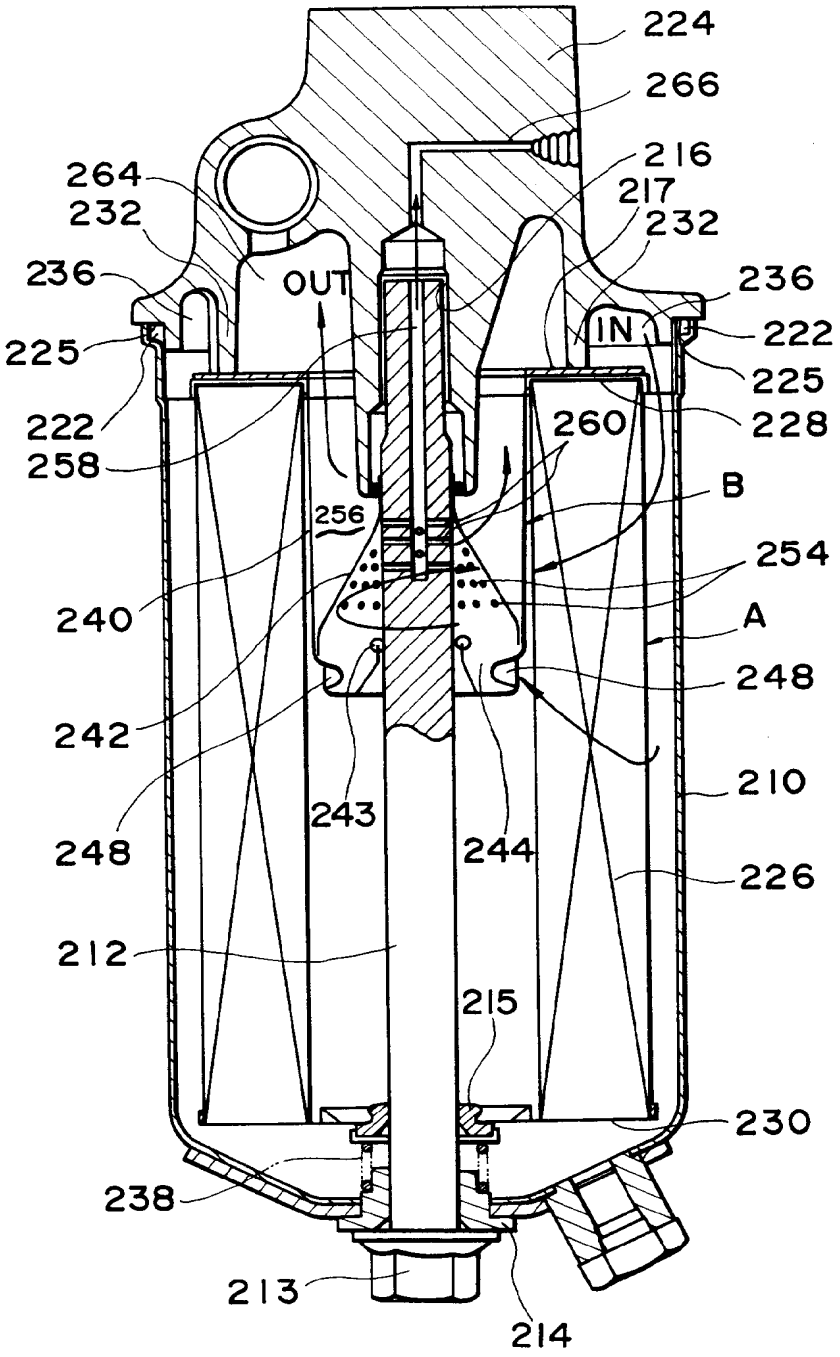


FIG. 14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232
264
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OUT
IN
236
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225
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228
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A
248
242
210
243
244
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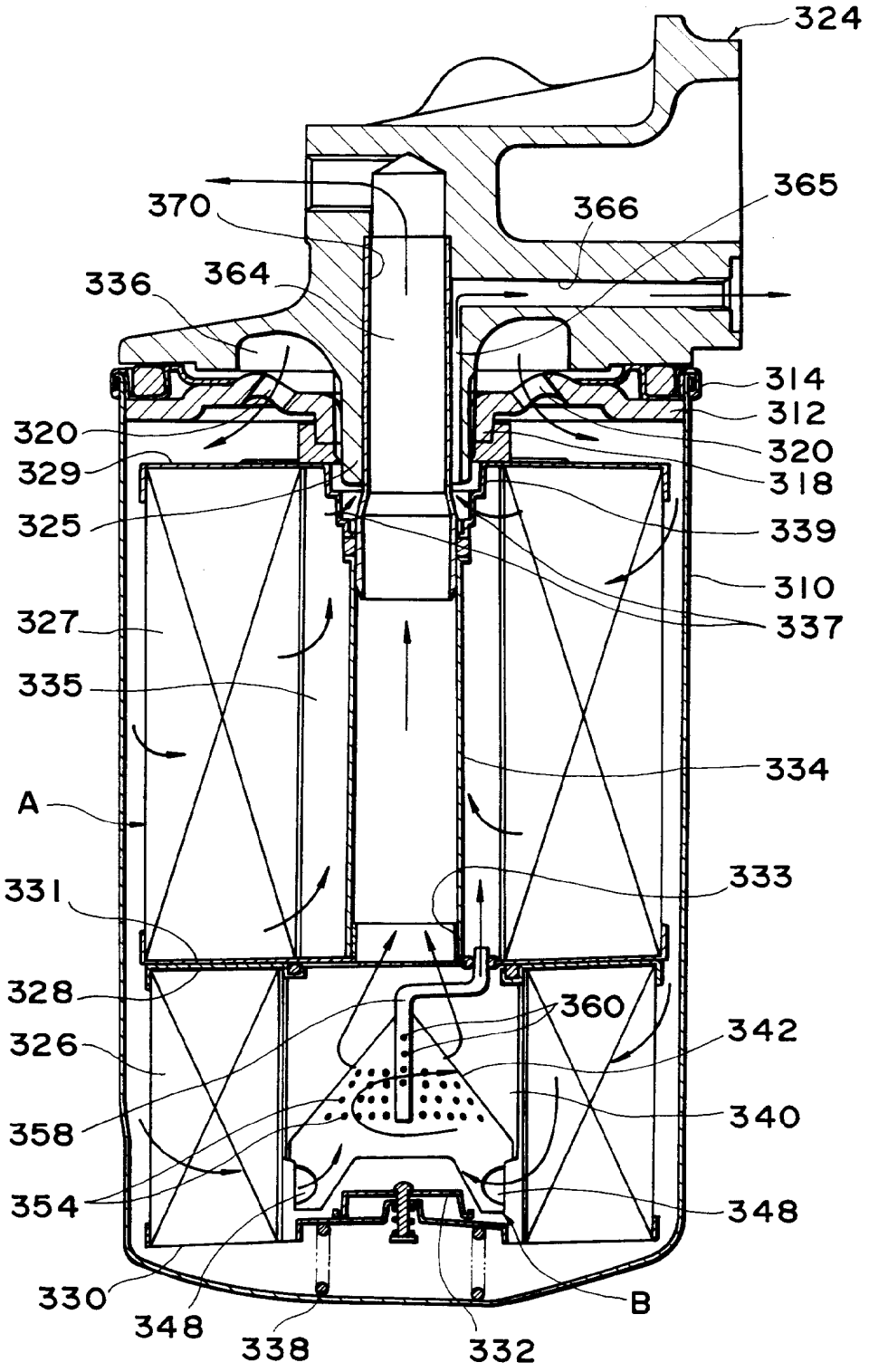
214

FIG. 15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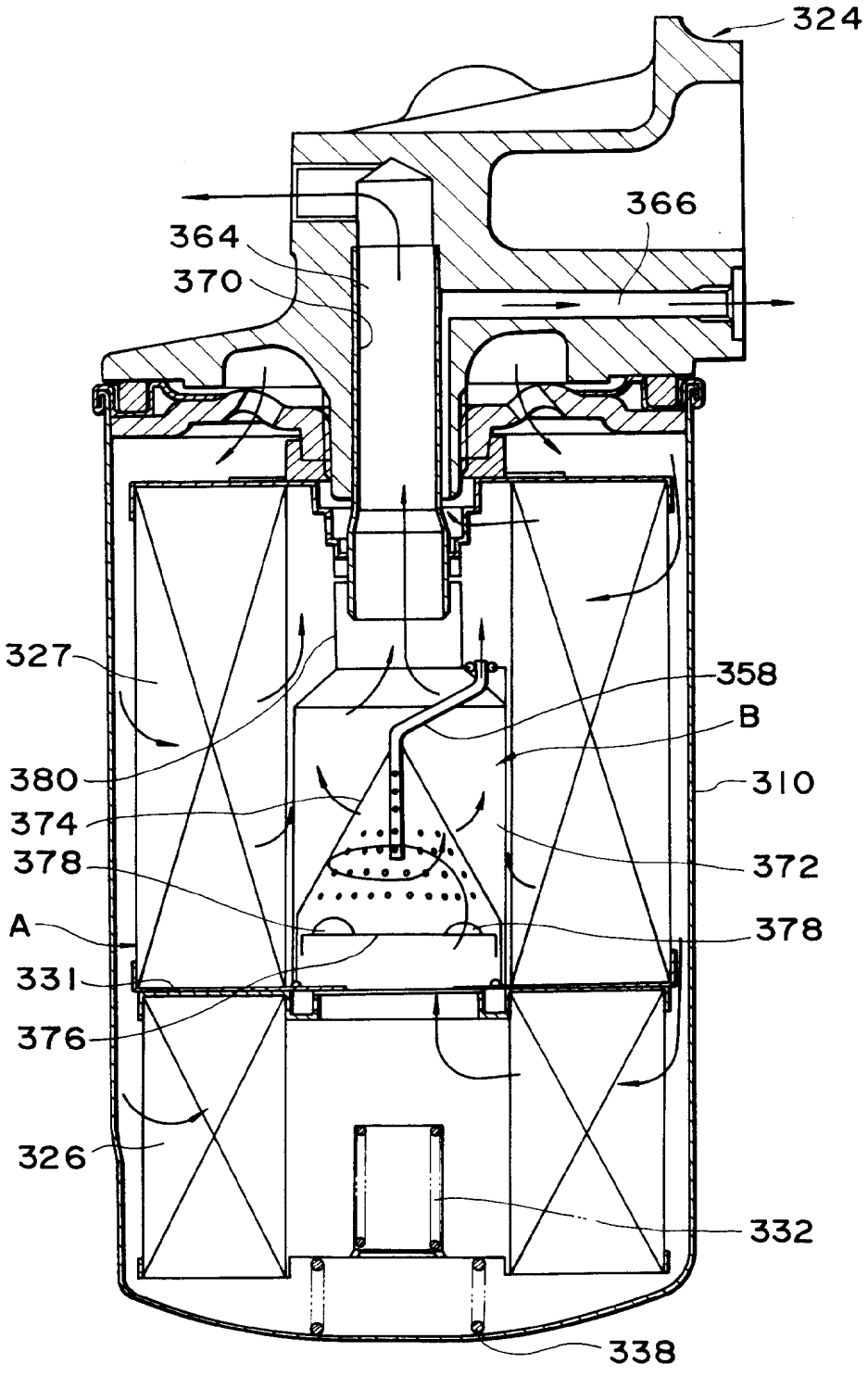
332
B

FIG. 16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A
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